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PLANNING LIGHTING INSTALLATIONS.
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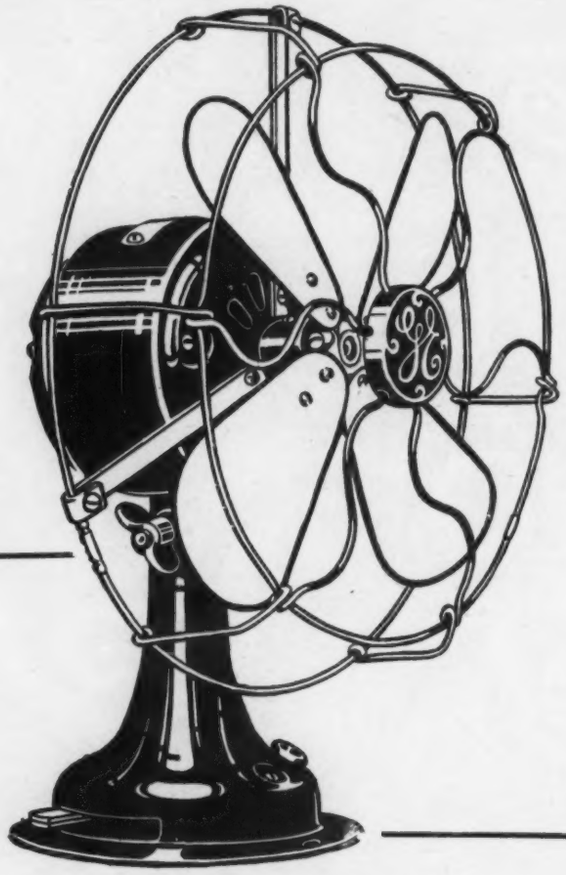
Summer
will soon be here

It's not a bit to early
to be thinking



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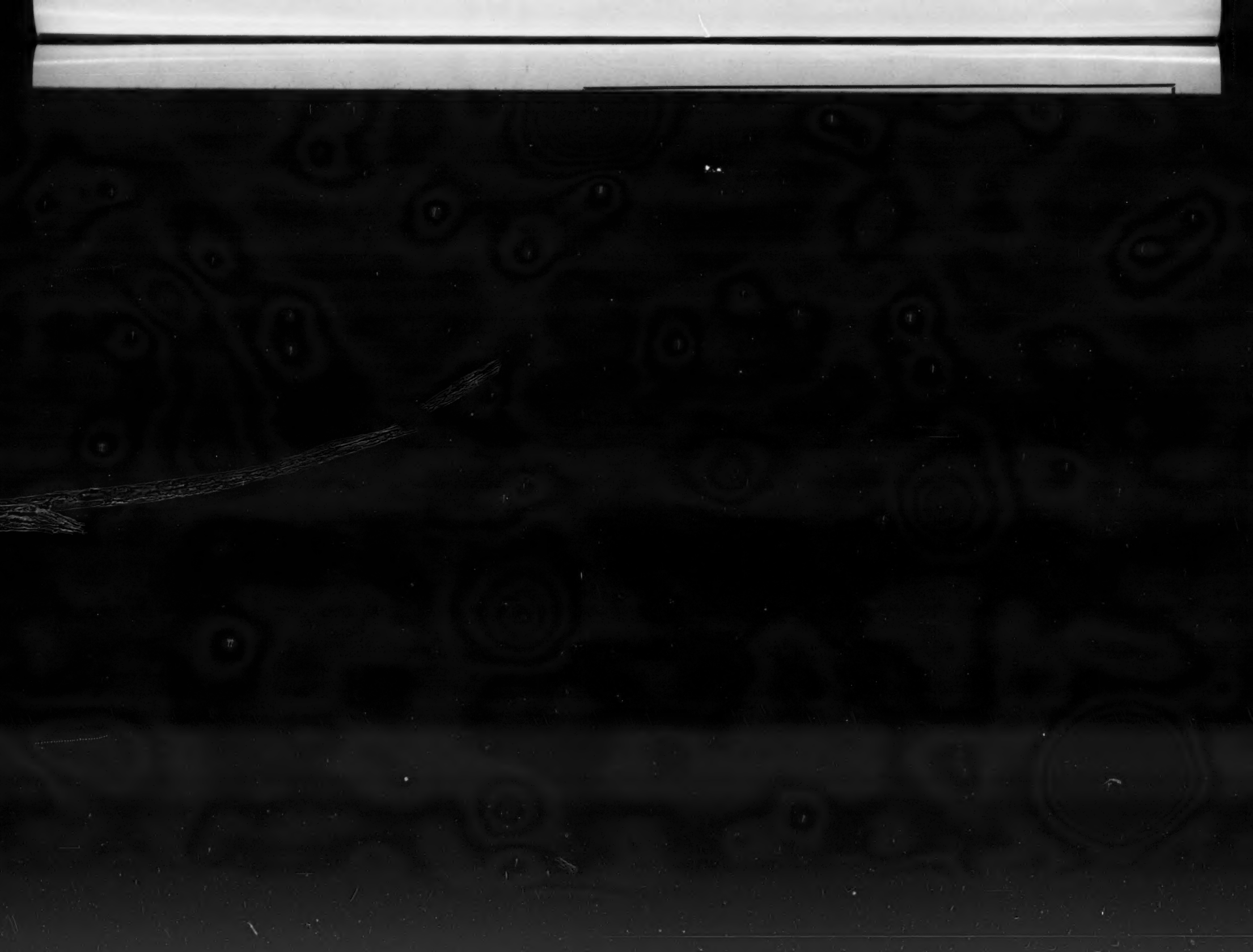

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HYDROELECTRIC PLANT COST CONSIDERATIONS

BY J. C. RALSTON.

(This syllabus or specification for the preparation of an estimate of cost of a hypothetical hydroelectric plant to serve, under municipal operation, a western city of 125,000 population, which it is assumed is already well served by a public utility corporation, was presented by Mr. Ralston who is a member, American Society of Civil Engineers, and a consulting engineer, Spokane, Wash., at a joint meeting of the Spokane Section, A. I. E. E.; Spokane Chapter, A. S. C. E.; Columbia Section, A. I. M. E.; and the Faculties of Engineering, and engineering students of the University of Idaho and Washington State College, held at Moscow, Idaho, January 17, 1914.—The Editors.)

Waterpower Is a Result Only of Development.

Assumed: A western inland city, population 125,000, now served by a public utilities corporation which of necessity for a city of this size would have two or more hydroelectric power plants, interconnected, and having a commensurate steam auxiliary power plant and a large storage battery plant.

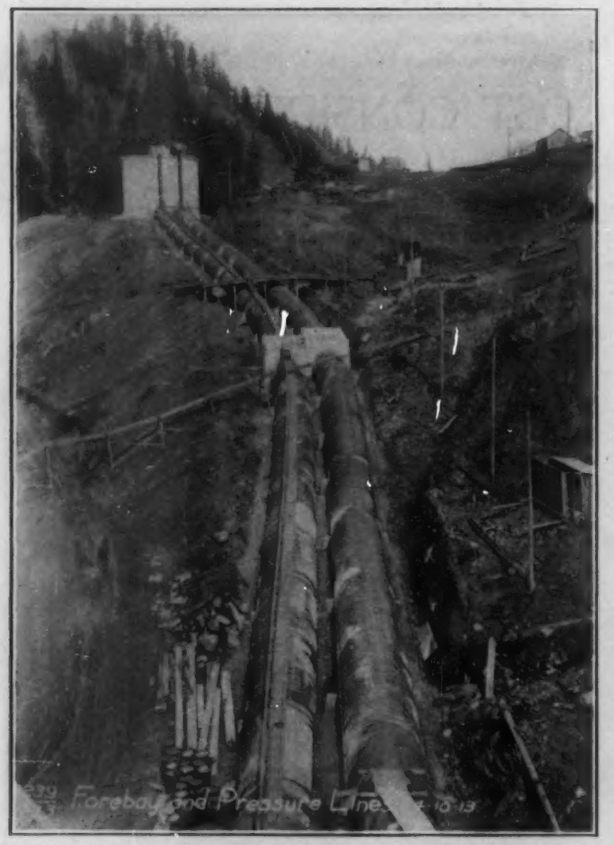
Also, a typical intermountain power stream supplying a low water flow of 2200 cu. ft. per sec. ft. Maximum flood discharge 20 times that of low water. A canon site, in rapids, with solid granite or basalt walls, 90 to 100 ft. high. Escarpment on one side, steep slope (say 60 degrees) with some talus on opposite side of river. Bench lands on both sides above walls of canon.

River at site 20 ft. deep and 70 ft. wide at low water level. Oscillation between high and low water

30 ft. Average fall of river above site for 20 miles 4.5 ft. per mile. Width of river bottom varying in width from 500 ft. to 3000 ft., with 50 per cent of same under cultivation.

Wagon road from city and adjacent farms on bench land runs within one mile of power site.

Standard gauge steam railroad 2.5 miles from site. Pacific Coast terminal rates to within 100 miles of site. Local railroad rates for 100 miles.



Forebay and Pressure Pipe Lines.

Banks of good gravel and sand within 1½ miles. Cement $2.50 per bbl. delivered by railway within 3 miles.

Timber delivered within 3 miles at $20.00 per M. b.m.; common labor $3.00; cement workers, $3.50; carpenters, mechanics and enginemen, $5.00; quarrymen, $4.00; two horse team, wagon and driver, $5.50, all for 8 hour day. This being a municipal job the preceding high wages are assumed to be fixed by municipal enactment, although on private work the wages prevail at from 9 to 17 per cent lower for a ten hour day.

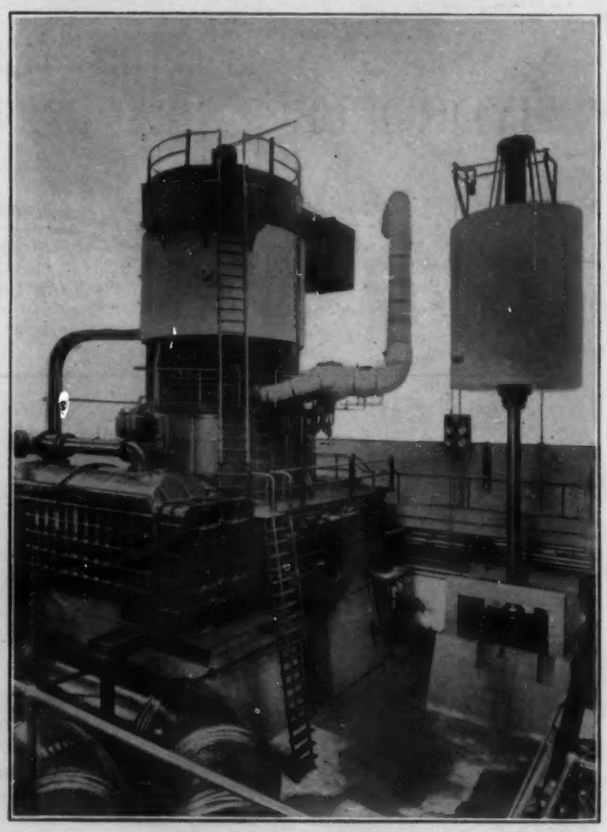
Fifty per cent of the uplands between site and city under cultivation, remainder mostly fenced, and 20 per cent of total is prime forest.

Character of present electrical market is typical of western inland cities, is already highly developed and, when viewed from a non-partisan standpoint, efficiently served.

Strong political sentiment, engendered and fostered in the customary quarters, succeeds in having the ratepayers, by a small majority vote, carry the bond issue for the installation of the municipal plant. This result has been secured even in the face of a five-fold increase in the municipal budget in the past decade.

Required: The cost of such a plant, also its operating and fixed charges, including taxes, interest on bonds, repairs and redemption fund. Depreciation must be computed by averaging the depreciation of the several elements in the plant.

Also, the probable ultimate division of the market between the proposed municipal plant and the



A Unit of the Steam Auxiliary.

present private corporation and the period in years in which the maximum load can be secured—i. e. the development period.

Population curves—growth, density, area, industrial growth, past and forecast graphs. Classes and number of services. Arc, pumping or other large special municipal services. Residence lighting, a.c. or d.c. Commercial lighting, d.c. Power, a.c. or d.c. or both, large and small runs. Rates, averages, demand, connected loads. Motor-generator set, capacity, connection and service.

Total of all classes of service in kilowatt hours, and progressive development of the same within the development period—to be set out in annual forecast statements until the end of the period is reached. These annual forecast statements must show each annual gross and net revenue in order to determine profits or deficits and the accumulation thereof. The development of the market must not conform to a straight line curve but to a sharply rising one for perhaps the first two or three years of the period, and thereafter to noticeably flatten, because of renewed activities on the part of the private service corporation and the usual awakening of the consuming pub-

lic to the efficiency of the private service, and to the inevitable inefficiency of a politically managed plant.

Also, the necessary bond issue, terms, life and probable market value. The municipality is assumed to have the legal right to incur such debt and to have favorably adjudicated such right.

Having thus briefly scheduled the assumptions and requirements, we may now proceed to an outline of the

Principal Subdivisions of the Estimate:

Cost of site by purchase or condemnation.

Cost of detailed surveys at site, of overflow rights of transmission alignment and ownership, of wagon roads, ets.

Geology—Fissures, faults, character and durability of rock, fault shattering, weathered penetration.
Outline of structural and dynamic conditions and results, of the geology.
Wagon roads, bridge, R. R. spur.
Dinky locomotives, dump cars, steam shovel.
Explosives and storage.
Also, a consideration of the economies of type, arrangement and capacity of plant, and the question of adaptability in lieu of certain of the preceding items, of a Lidgerwood cableway.

Materials of Construction—

Concrete, cement, sand, gravel or crushed stone.
Structural and reinforcing steel.
Dimension stuff, lumber.
Iron, round, strap, spikes, bolts, plate.

Coffer dams, type, dimensions, sealing, pumping, and excavation.

Stripping and founding and excavations, yardage and classification.

Diversion of river channel during construction—Method cost and resealing.

Cost of Construction Plant—

Derricks and engines and rigging, skips, etc., machine shop and wood-working plant, blacksmith shop and outfit.
Rock drilling and handling equipment.
Screens, Mixers, Bins, Elevators, Tracks, Tools, Supplies.
Temporary power—steam, air, electric. (If electric, its cost transmitted from present source with line, apparatus, etc.)
Compressor, capacity, cost, how driven, with its piping, housing, etc.
Workmen's quarters.
Water supply, tanks, piping, pumps and tanks.

Size of plant and economics of same—Main Dam, type, height, location, drainage of same, foundations, borings, excavation, sealing.

Spillway—Necessary length, surcharge, location, excavation, type and quantities.

Regulating and Retaining crest devices for holding receding waters.

Forebay and Ditch—Location, size, velocities, forebay spillway, blow-off, excavation, lining, retaining walls, trash racks or grizzlies, gates, valves, operating mechanism, its type and size.

Fish Ladder—Size, type, state requirements, etc.

Feeder pipes or penstocks—Sizes, kind, velocities, etc. (number determined by units in station.)

Tail Race—Depth, dimensions and face discharge, channel obstructions, lining and form.

Station floor elevation, in relation to high water—watertight bulkheading below that level. Distance to be determined between tail water at low water and turbine outlets, according to modern turbine practice, etc.

Generating Station—Size location, type, excavation for same.

Generating Station Equipment—
Number of units, capacity and characteristics. Capacity to be determined by assumed maximum connected loading, market demand and service.
Turbines — Type, r.p.m., regulation, dimensions, weight, feeder pipes, connections, anchorage.
Governors—Type, space and capacity.
Generators—Type, characteristics, weight, size, space, connections to turbines, exciters and their capacity, connections to generator shaft or separately driven. (If separate, include their actuating devices and equipment.)
Transformers—Size, type, location, connections, cables, oil or water supply.
Switch Board—Number of panels, type, instruments, switches, arresters, ducts, cables, wiring, switch calls and location of same.
Crane—Station supplies and machine shop with its equipment.

Overflow Rights—
Acreage, subdivisions of land and the acreage necessary to be purchased.

High Tension Transmission Line—
Steel towers, span, number of circuits. (The economics of the general question), capacities or sizes, copper vs. aluminum, length, insulators, ground wires, phone lines, right of way, voltage, power factor loss, clearing of right of way, danger, trees, easements vs. deeds.

Step Down Transformer Station—
Outdoors or housed? size or type. Location, relative to city limits or within city limits and relation to central substation.
Transformers, water or air cooled.
High tension and low tension switches.
Lightning arresters, switches, special devices, leads, insulation.
Fencing and real estate.

Low Tension Transmission Lines—
Lengths, number of circuits, voltage, pole lines, spacing, guying, right of way.
Power loss, volt drop, economics.
Size of conductors.
Length overhead.
Length underground, 3-conductor cables, ducts, manholes, trenching, etc. Manholes and sizes.
Insulators.
Routes.

Central Substation—
Economic location and real estate.
Equipment for diversified service.
Transformers, location in station and arrangement, dimensions, types.
Switchboards, sizes, types, switches, instruments and all apparatus.
Size and type of building.
(Type of apparatus largely determined by character of service of existing competitor.)
Load Factors—daily and annual.

Arc Lighting—
Number of arcs, distribution, mileage.
Transmission, overhead and underground.
General equipment.

Distribution System—
Residence lighting, meters, connections.
A.C. or D.C. Transformers, etc.
Mileage, number, location, routes, density.
Sizes of wires, duct feet, average number of conductors per duct.
(Scattered condition of western cities a serious factor in cost.)
Manholes in rock and in earth, sizes and State requirements, and equipment.
Galleries and tunnels.
Pavements and repaving and trenching.
Sub-basement depths in overcrowded underground conditions.

Steam Auxiliary—
Economic capacity, location, real estate.
Water supply, cooling surface.
Type of equipment, boilers, fuel and fuel storage and delivery—oil or coal.
Type and capacity of prime movers, size, speed, connection to generators.
Generators, size and characteristics.
Transformers, capacity, size, location, wiring. type, etc.
Switchboards, instruments, switches, synchronizers.
Size and type of building.

Summary of items with totals—
Industrial or accident insurance.
Engineering, legal and court expenses.
Contingencies.
Interest during construction.
Grand total.
Amount of bond issue, adding probable discount on bonds.

Operating Costs and Maintenance—
Power plant, attendants, oil, waste small repairs and small renewals.
High tension transmission, patrols and small repairs, ditto low tension transmission.
Step down station, repairs, attendants, oil, etc.
Distribution system, repairs, renewals, etc.
City substation, attendants, oil, renewals, etc.
Steam auxiliary, continuous stand-by help, fuel, oil, repairs and maintenance of ready to serve conditions.
Administration, accounting, quarters.
Taxes.
Interest on bonds.
Depreciation.
Total yearly expense.

Revenues—
Subdivision and classes, with rates and amounts in kw.-hr. and dollars.
Gross. Net—for development period and thereafter worked out for each year of period.
Annual profits, or
Annual deficits, for each year up to end of development period with accumulated deficits if any.

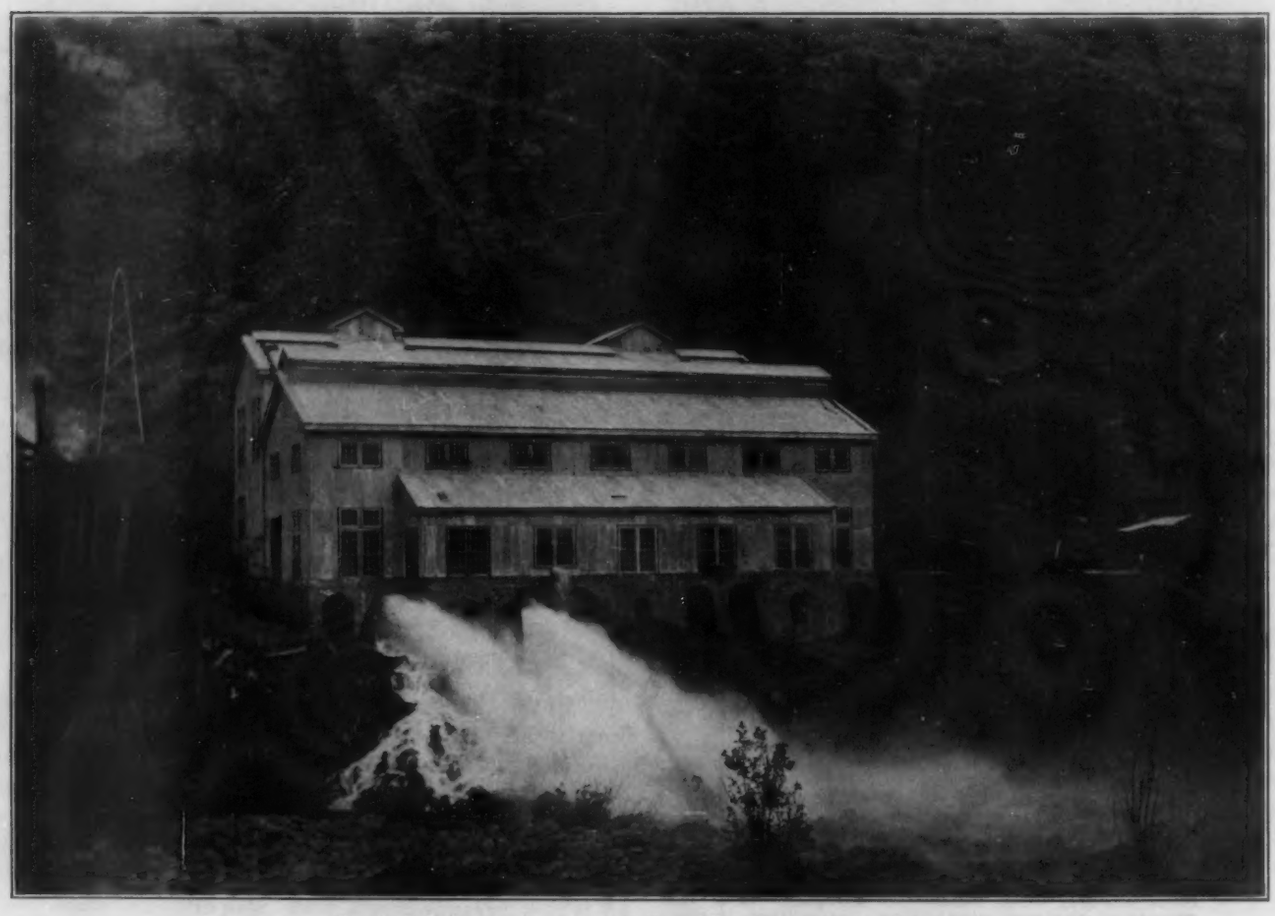
From the preceding outline it will be seen that nearly the whole technology of engineering is covered, offering, as it was designed to offer, a wide and fruitful field for discussion and investigation on the part of the student body.

An estimate of cost of such a plant following this syllabus groups itself into four broad heads each of which presupposes a wide and intimate knowledge of the respective subjects, viz: Technical, Economic, Financial, Political.

The fullness of the technologic elements is apparent, and needs no comment.

The economic questions are unusually diversified and comprehensive, beginning first with the broad question of the economy and advisability of such an investment in the face of a market which, as here assumed, is already well served, although in this instance the voters have decided that question, and so far as the engineer is concerned the question is at rest. But here is one of the fields in which the engineer seldom makes himself felt, be it said to his shame and his dereliction of citizenship duty. But further, economic studies, supplemented with technical ability, are involved throughout the whole process of making the estimate. The economic studies involved in determining the types to be adopted in the various units of the project from the best and most adaptable type of construction plant to the best strategic location of the central substation are also apparent. Furthermore, the question of day labor versus the letting of the work by contract is one of an economic character. These and kindred questions merge into the political questions of taxes, ways and means, efficiency or inefficiency of political methods and management, the functions of civic and other governmental bodies as well as the tendency now dangerously abroad in the land to destroy all forms of privately owned utility corporations. These are some of the reasons why the engineer, trained as he is and studious as he ought to be, should be the man of affairs and the leader of economic thought.

He must also know, as the preparation of the financial forecast suggests, something of the bond market and of the adverse or inviting qualities of such types of investments in a market which is already water-logged with municipal securities. He obviously cannot overlook the threatening fact that the "day of redemption" is no longer one for the divinity student to contemplate but is one which the engineer's client alone must face. The well-being of the latter is the prosperity of the former. Nor can he afford to be oblivious to the forbidding fact that the operative force, these piping days of political nostrums, is, too often, in public, semi-public or political thought, middle-class opinion. The haste with which economic questions that pertain to anything for which the public will be taxed is the result generally of this middle-class opinion. Often, too often, such questions are not corrected or checked by the best intelligence This middle-class opinion is a slave to words and catchy phrases, to specious argument, and is an instrument of utility in the hands of the self-seeking—the follower of the fatal short-cut, and is stamped with the hall-mark of political caprice. It is the mildew on the heart of progress; for it has been known to contradict the most elementary facts of economic conditions and grandiloquently to oppose all human experience.



Penstocks, Power House, Tail Race and Transmission Lines.

P. P. I. E. EXHIBIT SPACE FREE.

Intending exhibitors at the Panama-Pacific International Exposition will be much interested in the announcement made February 20, by President Charles C. Moore that the installation of exhibits may begin as early as July 1 of this year. This will enable the exhibitors to devote nine months to the preparation of their displays and will eliminate the annoyance and expense caused by the necessity of haste in preparation and installation.

The exposition is making no charge for space to exhibitors. Every effort is being made to assist the exhibitor and to reduce the expense incidental to exhibition. Arrangements have been made whereby manufacturers who need send less than carload lots may combine with other exhibitors through an accredited exposition agent and obtain the carload lot freight rate. The exhibit may be sent to a representative of the exposition at one of three central branch stations at St. Louis, New York and Chicago. The agent will assemble exhibits to obtain the carload rate and consign directly to the exposition.

A railroad has been constructed upon the exposition grounds and will pass through all of the exhibit palaces. Every facility will thus be given exhibitors in unloading and reloading exhibits. When desired exhibitors may combine so that but one attendant will be required for several exhibits.

An important announcement by the President of the P. P. I. E. follows

"We'll Be Ready."

BY CHARLES C. MOORE.

"The progress of the physical side of the Exposition work during the past year enables me to repeat with assurance the promise originally made two years ago when I said that the Panama-Pacific International Exposition would be ready when its gates opened on February 20, 1915.

"All construction work is fully up to schedule, and this schedule calls for the completion of the Exhibit Palaces by July 1, 1914. One of them, the great Machinery Palace, is practically completed now; several more will be finished in April or May and will be ready for the installation of exhibits by July 1st.

"Very active work has begun in the Concessions District on the many beautiful and elaborate structures to be erected by concessionaires to house their attractions. All these men are under rigid contract and bond to have their projects in complete working order on the opening day.

"Plans for the numerous State Buildings and for the Pavilions of foreign nations are now being submitted and approved in rapid frequency, and, whilst the Exposition itself has no direct control over the erection of these buildings, every influence that it may exert to expedite their completion will be exerted, and I apprehend no serious delays in this part of the site.

"There will be approximately 60,000 exhibits from all parts of the world installed in the main exhibit palaces. The work of selection of representative exhibits and the allotment of space will shortly be taken up and the installation of exhibits will begin about July 1st, thus giving exhibitors nearly nine months to get ready. Extraordinary care has to be taken to give exhibitors facilities for the rapid handling of their goods, and there is no reason why all the exhibits should not be completely arranged weeks before the gates are opened.

"These exhibits will make a representation of human achievement in the arts, sciences and industries which I believe has never been surpassed, or ever equalled.

"We have had over 7000 applications for concessions, and those that have been given space are on the highest plane as regards novelty, interest and attraction. Our amusement district will be pleasantly remembered for years after the Exposition closes.

"Two hundred and twelve national and international congresses have already voted to meet in San Francisco during 1915, and it is probable that the number of organized bodies which will assemble in 1915 in San Francisco will be fully 500.

"The plans for a great naval pageant are progressing well, and from assurances already received I am justified in believing that there will be few if any, nations possessing navies that will be unrepresented in the great fleet which will assemble at Hampton Roads, sail through the Panama Canal and through the Golden Gate to take part in our opening exercises.

"Detachments from the armies of many nations will gather in the Exposition grounds during 1915 and in friendly rivalry will illustrate their proficiency in feats of arms.

"The vast preliminary work of creating a great Universal Exposition is complete. The great responsibility confided by the Government of the United States to the people of California is being successfully executed.

"And as the Exposition palaces arise and the physical shell for this greatest of educative celebrations assumes that beauty in which the genius of master artists and architects conceived it, the people of America may rest assured that their pride and patriotism will find expression in a celebration that in its high educational value, in its ethical influence and in its splendor will worthily celebrate the supreme triumph of mankind in the Panama Canal."

To illuminate the cascades in the Court of Abundance at the Panama-Pacific International Exposition vapor tubes will be placed beneath the water and as vari-colored lights are produced in them, their delicate shades will glow through the falling water. Another striking illumination feature to be used in the Palace of Horticulture will make this huge palace a scene of grandeur and spendor. A battery of searchlights placed beneath the large dome of this building will project their rays through a revolving screen of various colors This will throw great shafts of colored light about the dome, illuminating the entire palace as well. The vast crystal dome of the Palace of Horticulture is 152 ft. in diameter and 186 ft. high, the greatest distance ever stretched by any similar structure of glass in the history of building construction. A plan for lighting the Court of the Sun and Stars with electric fountains also is being developed.

A REGULATION CHART FOR 50 CYCLE LINES.

BY H. B. DWIGHT.

A number of charts, more or less complicated, have been published for the determination of the electrical characteristics of transmission lines, especially the voltage and the regulation. Any chart can necessarily give only approximate results, since it is essentially a graphical solution. As the regular formulas for the approximate solution of a.c. lines, using standard tables of line constants, are not very complicated, a chart must possess distinct advantages of simplicity and rapid working in order to be useful to an electrical engineer. Keeping these requirements in mind, it is believed that the chart described herein is worthy attention, as it is easy to learn and to use, and applies to a.c. lines from a few hundred feet in length, to 100 miles.

In certain parts of the United States, notably in Southern California, the frequency of 50 cycles is used to a considerable extent, as well as the more standard frequencies of 25 and 60 cycles. The accompanying chart has been prepared for use in estimating distribution lines and transmission lines of 50 cycle systems. It is based on the similar chart for standard frequencies published by the writer in "Transmission Line Formulas" (D. Van Nostrand Co., New York, 1913.) A short description of the procedure of using the 50 cycle chart, with examples, will be given.

The necessary size of conductors for transmitting a certain load and conversely, the maximum load of a given alternating current transmission line or distribution line, are determined, in almost all practical cases, by the regulation of the line, that is, by the amount of variation in voltage due to changes in the load. For example, in many lines, the voltage at one end is kept at a constant value. Accordingly, at the other end the voltage will be normal at times of light load but will vary considerably when full load is being delivered. If this voltage variation amounts to 10 per cent or more, it is evident that the quality of service is impaired. The lowering of the voltage produces a noticeable change in the brightness of lamps, and the operation of motors is impaired by the reduction of starting torque and pull-out torque. These matters become of commercial importance at a load for which the transmission line efficiency is still high. Thus the regulation and not the cost of power for line losses is the feature on which the design of the line depends. In the majority of a.c. lines, voltage variation in some part is the chief disadvantage encountered in delivering heavy loads. The only exceptions are probably in very short distribution lines where the heating of the conductors limits the load, and in certain transmission systems where the voltage at all points is held constant, or poor regulation is partially overcome, by power factor adjustment by means of synchronous motors.

The chart described in this article is practically self-explanatory. A straight-edge is placed across the chart from the point on the left corresponding to the spacing of the conductors, to the point on the right corresponding to the resistance of one conductor per mile. The regulation factor, V, is then read directly from the chart for the power factor of load considered. This factor, V, is the change in receiver voltage per total ampere per mile of line, due to the line impedance, and from it the regulation of the line can be quickly found with a slide rule by means of the formulas on the chart. According to the usual practice, the regulation is expressed as a percentage of E, the receiver full load voltage. The regulation obtained is that of the line alone, and does not include that of transformers or protective reactance coils.

With transmission lines more than 30 or 40 miles in length, the charging current, due to the capacity of the line as an electrostatic condenser, has an appreciable effect, and produces a slightly higher receiver voltage than would otherwise be the case. Since this effect is present at both no-load and full load, it need not be considered in estimating the regulation, within the limits of accuracy and length of line given on the chart. But allowance must be made for the charging current in determining the line drop, that is, the difference in voltage between the supply end and the receiver end of a line. This is done very easily and accurately by means of the constant K, which is equal to 1.5, as shown on the chart.

The resistance points for standard conductors marked on the chart are for American Wire Gauge cables at 20 degrees C., assuming hard drawn copper of a conductivity equal to 97.3 per cent of the Annealed Copper Standard, and hard drawn aluminum of 60.86 per cent conductivity and allowing an increase of 1 per cent in resistance due to spiralling of the wires in the cable. The straight-edge may be set to any other values of resistance, and the chart is therefore applicable to all kinds of copper and aluminum conductors, except those having a steel core.

The spacing points on the chart are the same for both solid wire and cable. When the conductors of a three-phase line are not spaced at the corners of an equilateral triangle, but are at irregular distances a, b and c from each other, the effective spacing

$$s = \sqrt[3]{abc}$$

should be used. With regular flat spacing, where the middle conductor is at a distance a from the two outer ones, the equation for the effective spacing becomes simply

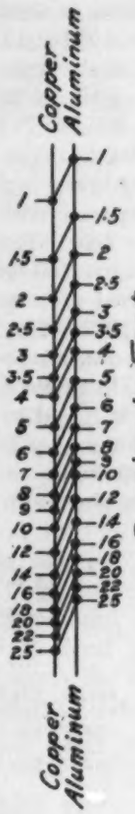
$$s = 1.26\,a$$

The effective spacing of a two-phase line is the mean distance between conductors of the same phase.

The problem of finding the size of conductor needed for a given load and a given regulation, is the converse to the problem discussed above, of finding the regulation of a given line. A direct solution of this converse problem cannot be obtained by any method of calculation. Hence, an important advantage of the chart is that it solves directly this very practical and useful problem. First, V is found from the formula on the chart. Then a straight-edge is placed through V and the point for the spacing to be used, and the required size of conductor can be seen, at a glance, on the resistance scale at the right.

An equation is given on the chart for solving another converse problem, namely, that of finding the k.v.a. which can be transmitted over a certain line with given regulation. Examples of the various classes of problems are added, to show the method of operation, and also the range and accuracy of the chart.

CHART FOR REGULATION OF 50 CYCLE TRANSMISSION LINES AND DISTRIBUTION LINES



Correct within approximately ½ of 1% of Line Voltage for Lines up to 100 Miles long, and with Regulation up to 10%.

Lay a straight-edge across the chart from the spacing point to the resistance point, and read "V."

$$\%\ \text{Reg'n.} = \frac{100\,000\ \text{K.V.A.} \times l \times V}{E^2}$$

$$\text{Reg'n. Volts} = \frac{100\,000\ \text{K.V.A.} \times l \times V}{E}$$

$$\text{K.V.A.} = \frac{\%\ \text{Reg'n.} \times E^2}{100\,000 \times l \times V}$$

$$\%\ \text{Line Drop (per cent of E)} = \%\ \text{Reg'n.} - 100K\left(\frac{l}{1000}\right)^2$$

$$\text{Line Drop} = \text{Reg'n. Volts} - EK\left(\frac{l}{1000}\right)^2$$

where

K = 1.50 for 50 Cycles
E = Line Voltage at Load
K.V.A. = K.V.A. of Load
l = Length of Line in Miles

Effective Spacing of 3 Phase Line

$$s = \sqrt[3]{abc}$$

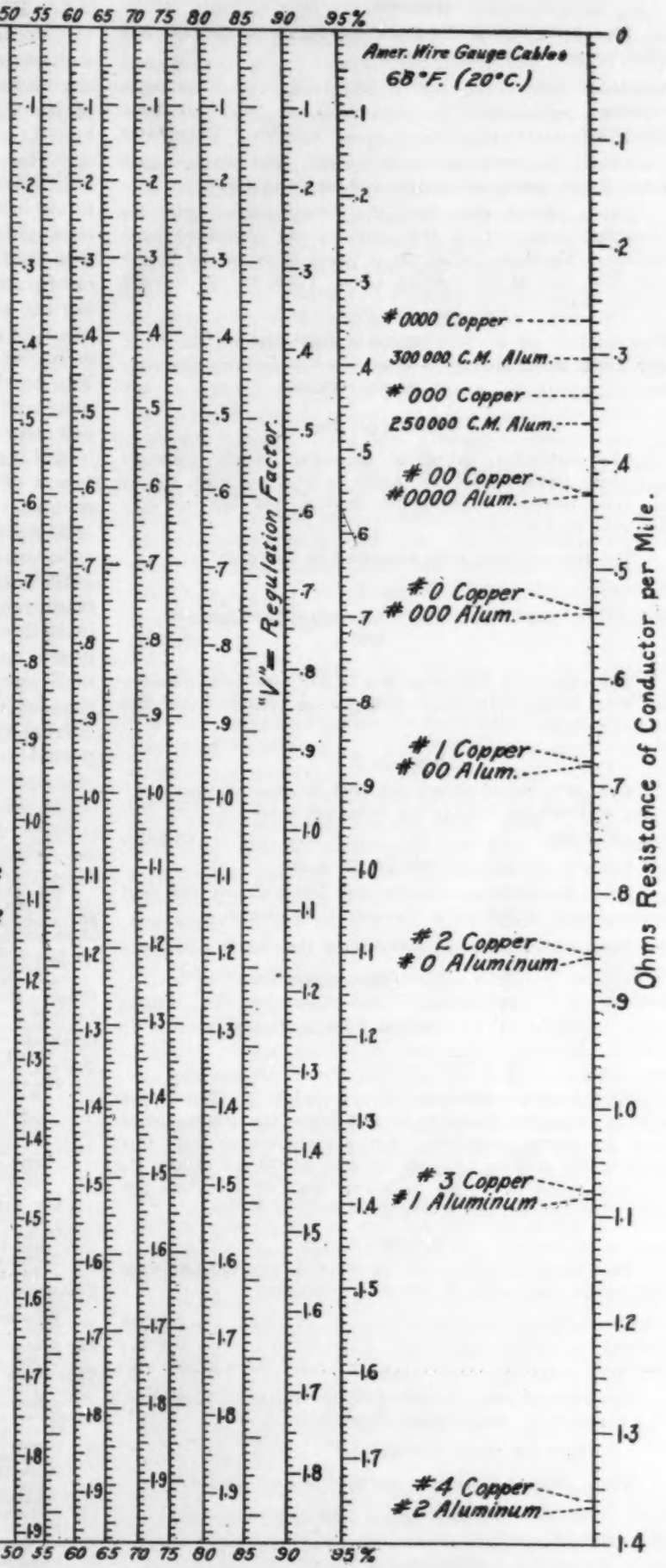
$$s = 1.26\ a \text{ for Flat Spacing}$$

To determine the Size of Conductor required for a given % Regulation, use the following :–

$$V = \frac{\%\ \text{Reg'n.} \times E^2}{100\,000\ \text{K.V.A.} \times l}$$

The above Equations are for 2 and 3 Phase Lines. For Single Phase use 2V in place of V.

K.B.D.



Problem 1.

Find, by means of the chart, the regulation and the line drop for the following case:

Length of line ..... 100 miles
Spacing ..... 8 feet
Conductor .....No. 1 alum. cable

Load, measured at receiver end, 3500 k.v.a., 66,000 volts, 85 per cent power factor, 3-phase, 50 cycles.

Lay a straight-edge from the 8-foot spacing point for aluminum conductor, to the point on the resistance scale for No. 1 aluminum cable. It is found to cross the 85 per cent P. F. line at the reading 1.275. Then, by the formula on the chart,

$$\text{Per Cent Regulation} = \frac{100{,}000 \times 3500 \times 100 \times 1.275}{66{,}000 \times 66{,}000}$$

$$= 10.2 \text{ per cent.}$$

The regulation, calculated according to the standard hyperbolic transmission line theory, is 10.37 per cent, and so the error involved in using the chart is less than 1/5 of 1 per cent of line voltage.

The per cent line drop, according to the chart, is

$$10.2 - 100 \times 1.50 \times \frac{1}{100} = 8.7 \text{ per cent.}$$

The calculated line drop is 8.76 per cent and therefore the error in using the chart is less than 1/10 of 1 per cent of line voltage.

Problem 2.

Find the size of copper required to give approximately 8 per cent voltage drop in the following case:

Length of line ..... 12 miles

Regular flat spacing, wires 4 ft. apart

Load, measured at receiver end, 750 k.v.a., 70 per cent power factor, 11,000 volts, two-phase, 50 cycles.

First, find V from the formula on the chart.

$$V = \frac{8 \times 11{,}000 \times 11{,}000}{100{,}000 \times 750 \times 12}$$

$$= 1.075$$

The effective spacing is 1.26×4, or 5.04 ft. The proper spacing point will therefore be just below the spacing point for 5 ft., copper conductor. Lay a straight-edge from this point to the reading 1.075 on the line for 70 per cent P. F., and it is found to cut the resistance scale at 0.88 ohms per mile. The nearest size of copper is seen to be No. 2.

Problem 3.

Find the k.v.a. which can be delivered by the following single-phase line with 10 per cent regulation:

Length of line ..... 2 miles
Spacing ..... 1½ ft.
Conductor .....No. 0 copper wire

Character of load (measured at receiver end), 2200 volts, 90 per cent P. F., single-phase, 50 cycles.

From the chart, V = 0.70.

Then, using 2 V because the line is single-phase.

$$\text{K.v.a.} = \frac{10 \times 2200 \times 2200}{100{,}000 \times 2 \times 2 \times 0.70}$$

$$= 173 \text{ k.v.a}$$

ELECTRIC RAILWAY STATISTICS.

Preliminary figures of the forthcoming quinquennial report on the electric railways of the state of California have been given out by Director W. J. Harris of the Bureau of the Census, Department of Commerce.

The statistics relate to the years ending December 31 for 1912 and 1907, and June 30 for 1902. The totals include electric light plants operated in connection with electric railways and not separable therefrom, but do not include reports of mixed steam and electric railroads nor railways under construction during the census year which had not begun operations.

The figures presented for California show general gains in the industry during the decade 1902-1912. The number of electric railway companies in the state increased from 35 in1902 to 44 in 1912, a gain of 26 per cent. The gross income amounted to $34,845,771 in 1912 as compared with $9,967,838 in 1902, an increase of 250 per cent. The revenue passengers carried numbered 520,741,159 in 1912 as compared with 182,196,999 in 1902, an increase of 186 per cent. The miles of track increased from 829 in 1902 to 2606 in 1912, a gain of 214 per cent. The number of persons employed were 16,749 in 1912 as compared with 5442 in 1902, an increase of 208 per cent. The total horsepower increased from 38,085 in 1902 to 48,311 in 1912, or 27 per cent, but the bulk of the power consumed by the electric railways was purchased as current, 481,625,400 kilowatt hours of purchased current being reported in 1912. The figures in detail are shown in the accompanying table:

California.

	1912.	1907	1902	Percent of increase:[1] 1902-1912.
Number of companies..	44	42	35	25.7
Operating	35	41	35	....
Lessor	9	1	....	....
Miles of line	1,766.20	1,264.10	551.40	220.3
Miles of single track ..	2,606.40	2,013.49	829.10	214.4
Cars, number	4,652	3,760	2,056	126.3
Passenger	2,791	2,406	1,850	50.9
All other	1,861	1,354	206	803.4
Electric locomotives ...	49	15	....	....
Persons employed	16,749	11,466	5,442	207.8
Salaries employees,	1,784	904	255	585.5
Wage earners (average number) ...	[2] 15,001	10,562	5,187	189.2
Power:				
Horsepower, total..	48,311	60,655	38,085	26.8
Steam and gas engines (including turbines):				
Number	46	52	74	—37.8
Horsepower ..	48,046	60,455	31,590	52.1
Water wheels:				
Number	3	2	8	—62.5
Horsepower ..	265	200	6,495	—59.2
Kw. capacity of dynamos	30,817	44,400	22,897	34.6
Output of stations kw.-hr.	11,274,069	111,870,849	44,676,030	—74.8
Current purchased, kw.-hr.	481,625,400	[3],	[3]	.....
Passengers carried	683,326,934	441,895,205	241,325,720	183.2
Revenue	520,741,159	327,977,151	182,196,999	185.8
Transfer	150,298,412	109,230,255	55,128,721	154.2
Free	12,287,362	4,687,799	[3]	.....
Car mileage (passenger, express, freight, etc.)	116,553,876	74,785,472	41,512,788	180.8
Condensed income account of operating companies:				
Gross income[4]	$34,845,771	$21,545,797	$9,967,838	249.6
Operating expenses.	$21,684,312	$14,578,367	$5,402,245	301.4
Gross income less operating expenses	$13,161,459	$6,967,430	$4,565,593	188.3
Deductions from income (taxes, fixed charges, and miscellaneous)	$10,696,969	$6,732,705	$2,112,959	406.3
Net income	$2,464,490	$234,725	$2,452,634	0.5

[1] A minus sign (—) denotes decrease.
[2] Number employed Sept. 16, 1912.
[3] Figures not available.
[4] Income from sale of electric current included in 1912, $75,817; 1907, $366,566; and 1902, $279,216.

CENSUS FIGURES ON ELECTRIC LIGHT AND POWER.

Preliminary figures of the forthcoming quinquennial report on the central electric light and power stations of the state of Oregon have been given out by Director W. J. Harris, of the Bureau of the Census, Department of Commerce. They were prepared under the supervision of W. M. Steuart, chief statistician for manufactures.

The statistics relate to the years ending December 31 for 1912 and 1907, and June 30 for 1902, and cover both commercial and municipal electric plants. They do not include electric plants operated by factories, hotels, etc., which consume the current generated, those operated by the Federal Government and state institutions, or plants that were idle or in course of construction.

The figures as presented for Oregon show that during the decade 1902-1912 there were substantial gains. The number of establishments in 1912 was 66 as compared with 39 in 1902, or an increase of 69 per cent. The total income in 1912 amounted to $1,406,144 as compared with $691,582 in 1902, or an increase of 103 per cent. The total expenses amounted to $1,205,738 in 1912 as compared with $499,632 in 1902, or an increase of 141 per cent. The total horsepower of engines amounted to 16,213 in 1912 as compared with 6,603 in 1902, or an increase of 146 per cent. The total horsepower of the water wheels increased from 11,195 in 1902 to 29,802 in 1912, or 166 per cent. The output of stations was 58,789,342 kilowatt hours in 1912 as compared with 17,531,660 in 1902, or an increase of 235 per cent. The estimated number of arc lamps wired for service showed a decrease in 1912 as compared with 1902, numbering 1285 for the former year and 2023 for the latter, or a decrease of 37 per cent. All other varieties of lamps, however, increased from 95,045 in 1902 to 382,196 in 1912, or 302 per cent.

The figures are shown in detail in the accompanying table:

Oregon.	1912.	1907.	1902.	Per cent of Increase:[1] 1902-1912.
Number of establishments.	66	61	39	69.2
Commercial	54	50	33	63.6
Municipal	12	11	6	100.0
Income	$1,406,144	$1,965,245	$691,582	103.3
Light, heat and power	$1,364,226	$1,840,155	$638,571	113.6
All other sources	$41,918	$125,090	$53,011	—20.9
Total expenses, including salaries and wages	$1,205,738	$1,283,560	$499,632	141.3
Total number of persons employed	532	467	187	184.5
Total horsepower	46,015	126,815	17,798	158.5
Steam and gas engines (including turbines):				
Number	63	65	37	70.3
Horsepower	16,213	24,259	6,583	146.3
Water wheels:				
Number	60	72	46	30.4
Horsepower	29,802	102,052	11,195	166.2
Auxiliary engines:				
Number	([2])	7	2	.....
Horsepower	([2])	504	20	.....
Kw. capacity of dynamos.	32,416	32,587	11,165	190.3
Output of stations, kw.-hr.	58,789,342	92,807,992	17,531,660	235.3
Estimated number of lamps wired for service:				
Arc	1,285	[3] 3,927	2,023	—36.5
All other varieties	382,196	[3] 372,844	95,045	302.1
Stationary motors served:				
Number	1,527	2,072	403	278.9
Horsepower capacity	15,843	20,452	4,020	294.1

[1] A minus sign (—) denotes decrease.

[2] Not reported separately.

[3] Exclusive of 31 arc and 2,516 lamps of other varieties reported by the electric companies as used to light their own properties. Lamps used for such service were included in the number reported for 1912.

OUTDOOR INDIRECT LIGHTING.

A system of lighting never before utilized in expositions—for the reason that the mechanism making it possible has never before been perfected, will maintain, at night, the chief zone of illumination throughout the 625 acres of the grounds of the Panama-Pacific International Exposition to a height of 125 ft., with a variation of but five per cent throughout this height.

This light will for the most part be created by nitrogen filled lamps similar in form and principle to the ordinary incandescent lamp, save that here the metal filament burns not in a partial vacuum, but in an atmosphere of nitrogen gas. The light of this lamp is intense and one the size of an ordinary 32 candlepower bulb, will give 2500 candlepower. The lamps will be ranged up and down standards of from ten to thirty feet in height, and the eye of the observer will be shielded from the powerful direct rays by metal banners. In fact, all the lighting of the exposition palaces and grounds will be by the indirect "flooding" system, from concealed sources. The main advantage of this system over the old outline plan of using electric bulbs along the architectural lines of buildings, as at previous expostions, is that it permits the beauty of perspective and shadows to be preserved.

Realizing that the old outline system, with all its crudities and faults, had certain merits, the exposition engineers and architects have substituted polished jewels of hardest glass, with which the architectural lines and ornamentation upon the palaces will be emphasized. These jewels are of various colors, cut like huge rose diamonds, and are hung upon pendants so that they tremble constantly with the natural vibration of the palaces, while the least breath of breeze has the effect of causing them to flame into life, and the walls of the palaces to glow with multicolored fire, like live coals which have been blown open.

The searchlight scintillator, which in a modified form, was experimented with during the Hudson-Fulton celebration, will be used in its perfected form, from a tower upon an outjutting point enclosing the yacht harbor. A battery, the most powerful ever seen in this country, composed of forty-eight 36-in. searchlight projectors, will throw intense rays of light through color diffusers, which will separate the flood into fan shaped rays of all colors of the spectrum. These rays will be thrown upon the jeweled walls of the palaces, and upon the gardens and courts, and will play upon the beautiful white fog banks which often at twilight roll in through the Golden Gate.

In order to enhance the sense of magic, the builders of the exposition have forbidden the use of clocks architecturally, even in the amusement concessions, that the count of time with the pressure of everyday ideas and duties may not intrude upon the visitor. There shall be "no time"—"neither night nor day"—at the exposition.

Electric light and power meters rejected in Western Canada under government inspection during the year ending March 31, 1913, amounted to the small total of but twenty-two out of 28,780 meters inspected.

LIGHTING METHODS

PLANNING LIGHTING INSTALLATIONS.

BY J. B. JACKSON.

(The author, who presented this paper before a recent joint meeting of the Illuminating Engineering Society and the Chicago Architects' Business Association, gives a simple method of calculating illumination which, though approximate, will be valuable as applicable to the majority of lighting installations.—The Editors.)

It has not been uncommon in the past that provisions have been made for a certain number of outlets for an interior and the actual design of lighting equipment left until the building is practically completed. Very little consideration has been given in a great many instances to the factors which influence illumination results. This imposes conditions which are later very hard to meet, and the design usually becomes a matter of compromise. To obtain definite predetermined results it is necessary to know in advance the general scheme of decoration and the type of lighting equipment desired, and provision must be made for its correct use.

Methods of planning lighting installations have been the result of gradual evolution of the use of different illuminants and the introduction of new light units of higher illuminating value and in general have scarcely kept abreast of recent developments. The high power gas and the tungsten incandescent units require somewhat different treatment than did the open flame burner and the carbon incandescent units.

With the information now available it is possible to successfully apply engineering principles to the design of lighting installations and obtain results which are satisfactory in every respect. It is essential in considerations of light sources to have a clear conception of light as a quantity. Every lighting unit is capable of being evaluated in terms of a standard. It is unfortunate that the term candlepower has received such wide application. This would not be such a serious condition were it not for the fact that every unit has been referred to in terms of its maximum candlepower and has as a consequence given rise to some very erroneous conclusions.

If we consider a light source suspended in the center of a sphere in such a manner that all the light is intercepted by the interior surface and make use of some method of either measuring or calculating the light inclosed within the sphere, we then have a direct means of comparison of one light source with another. It is evident then that if light sources are expressed in terms of their average candlepower (otherwise called mean spherical candlepower) we may then make comparisons since the last quantity always bears a definite relation to the total flux of light.

A standard unit of luminous flux has been chosen which is designated the lumen, which for the purpose of this paper need only be defined as a measurable quantity of light, equal to 12.57 times the mean spherical candlepower. Table I is an evaluation of the different kinds of incandescent electric lamps which have been used or are in use at the present time. The first column gives the common designation as to kind of filament or some common characteristic which has been associated with the lamp. The second gives the nominal candlepower (in case of the incandescent units being in the horizontal direction). The tungsten or Mazda units have usually been expressed in terms of watts consumed, hence their horizontal candlepower values are not so commonly known. The third gives the energy consumption expressed in watts. The fourth column contains the value of the lamps in terms of light units (lumens) as referred to above and may be taken as a measure of the illuminating value. The last column contains a multiplying factor to be used as will be explained later. In the consideration of this table it should be remembered that these values apply to the quantity of light given off by the lamp unequipped with reflector, globe or other accessory.

Table 1—Lamp Values.

Kinds of Filament.	Horizontal or Nominal C.P.	Watts.	Light Units. (Lumens)	Multiplying Factor.
Carbon	2	10	21	4.95
Carbon	4	20	50	3.84
Carbon	8	30	96	3.02
Candelabra Carbon	8	31.1	96	3.10
Gem	20	50	207	2.31
Gem	32	80	337	2.28
Tungsten	7.7	10	76	1.26
(Mazda)	12.0	15	118	1.22
(Mazda)	17.1	20	168	1.14
(Mazda)	21.9	25	215	1.12
(Mazda)	36.4	40	357	1.08
(Mazda)	56.0	60	549	1.05
(Mazda)	98.0	100	960	1.00
(Mazda)	167.0	150	1687	.883
(Mazda)	278.0	250	2722	.882
(Mazda)	445.0	400	4535	.847
(Mazda)	556.0	500	5665	.847

The next question which naturally arises is how are we to determine the amount of light on any surface, also how are we to obtain a measure of the light required for certain classes of service. If we can imagine that light is radiated from a source in the form of rays and let some surface intercept a portion of these rays, it is evident that the number of rays which fall on a unit area represents a measure of the flux density or the density of the light rays upon the surface. If a standard be chosen which will represent a certain flux density then it is possible to measure by means of photometric apparatus any flux value in terms of this standard. This standard representing also the number of lumens per sq, ft. impinging on the illuminated surface, has been given the name foot candle. It should be considered as being only a measure of the density or intensity of the illumination produced.

Suppose an observer place himself in a position before a desk with a printed sheet of standard size type and we vary the illumination upon this sheet and when the illumination has reached a value which satisfies the observer a measurement is taken. By taking a series of these readings and obtaining an average value it is possible to state that for that observer the intensity value obtained may be considered as satisfactory for that class of service. These values vary in different observers, as one authority (Cravath) has stated, as much as 5 to 1. The following table gives the values in foot candles for different

classes of services and have been obtained by following methods similar to that above described. An average value has been obtained in some installation which has been classed as satisfactory.

It has often been stated that one system of lighting requires less intensity than another but there is not sufficient authoritative data along this line to warrant any such assertion. Regarding the most recent tests, the U. S. Postal Car Specifications contains the requirement that the illumination shall be not less that 2.8 foot candles, in parts of a car used for reading letter addresses, this value being comparable to the requirements for desk and office purposes. There seems to be considerable tendency toward requiring more and more light. In other words, our standards are raising gradually, probably not due to any changes in the human eye but more likely because illumination is now readily and cheaply obtained.

It will be noted that the values given in the table are in ranges, such as 2 to 4 ft. candles; being given in this manner to allow some opportunity for the designer to make a choice according to his knowledge of the actual service required. Values given in the table are an average for the entire room.

Table 2—Foot Candle Intensities Recommended for Various Classes of Service.

General—		**Offices—**	
Armory	2.0	Small Office (Private)	3.0— 6.0
Art Gallery (Walls)	5.0—10.0	Small Office (General Use)	3.0— 5.0
Auditorium	1.0— 3.0	Large Office (General Illumination)	3.5— 5.0
Automobile Showroom	3.0— 6.0	Large Office (With Desk Lights)	1.5— 2.0
Bank (General)	2.0— 3.0		
Bank (Desks)	4.0— 6.0	**Residences—**	
Billiard Room (General)	.8— 1.5	Hall	.7— 1.0
Billiard Table	6.0—10.0	Parlor	1.0— 3.0
Cafe (General Only)	2.0— 4.0	Living Room	1.5— 2.5
Cafe (With table lights)	1.0— 2.0	Library	1.5— 2.5
Card Room (Tables)	2.0— 3.0	Dining Room	1.0— 3.0
Church	1.0— 2.5	Kitchen	2.0— 3.0
Drafting Room	6.0—12.0	Laundry	1.5— 2.0
Desk	4.0— 6.0	Bedroom	1.0— 3.0
Engraving	10.0—12.0	Bathroom	2.0— 3.0
Factory (General Only)	.8— 1.5	Store & Furnace Rooms	.4— .8
Local Bench (Fine Work)	5.0—10.0		
Local Bench (Coarse Work)	3.0— 5.0	**Stores—**	
Gymnasium	1.0— 3.0	Clothing	4.0— 7.0
Hotel—		Dry Goods	4.0— 7.0
Bedroom	1.5— 2.0	Furniture	2.0— 4.0
Corridor	.6—	Grocery	2.0— 4.0
Dining Room (General)	2.0— 4.0	Hardware	2.0— 4.0
Dining Room (Lights on Tables)	1.0— 2.0	Jewelry	4.0— 6.0
Lobby	2.0— 4.0	Millinery	4.0— 6.0
Library—		Shoes	2.0— 4.0
Stock Room	1.6— 2.0	Stationery	2.0— 4.0
Reading Room (General)	3.0— 4.0	Warehouse	.5— 1.0
Reading Room (With Local)	.7— 1.5		

There are two classifications of fixtures in general use at the present time, namely ceiling and bracket. Of these the ceiling fixture is much more efficient as a lighting unit. With the spacing of ceiling outlets placed in the center of approximate squares we approach the nearest to the condition of uniform illumination which for most purposes is considered to be ideal. The use of bracket fixtures for general illumination is not to be recommended and should be used only when some consideration is given to special or decorative features. In commercial work, it is safe to state that the bracket fixture has very limited application. The fixtures of this type have often been installed and the reason for doing so advanced that they can be used for connection for fans, portable lamps, etc. This is not to be encouraged as baseboard and floor receptacles make a much more convenient and sightly connection and as a general rule at a cheaper installation cost. If sufficient capacity were installed for bracket fixtures for general illumination the center of the room would be darker than near the walls. Under these conditions objectionable glare is almost always introduced as the usual bracket is much too low for use under these conditions.

Table 3—Desirable Sizes of Squares.

Kind of Room.	Ceiling Height. ft.	Desirable length of Side of Square. ft.
Armories	12—16	12—16
Auditoriums	12—16	12—16
Public Halls	over 16	15—26
Rinks	over 16	15—26
Stores	8—11	8—11
Stores	11—15	10—16
Stores	over 15	14—22
Offices with desk lamps	10—20	12—18
Offices without desk lamps	9—12	7—11
Offices without desk lamps	12—16	9—14
Offices without desk lamps	over 16	11—18

As stated above the most even distribution of light is obtained by the use of ceiling units spaced in the center of squares or rectangles approaching square. The size of these squares are determined by features of the space to be illuminated, such as dimensions of bays and ceiling height. Table 3, given below, shows desirable sizes of squares for location of ceiling outlets under different ceiling heights and for different classes of buildings.

[To be continued.]

INSTALLATION OF HIGHER EFFICIENCY MAZDA LAMPS.

As the new higher efficiency Mazda incandescent lamps have now been developed for commercial purposes and the 1913 Edition of The National Electrical Code does not contain rules to govern, completely, installation of such units, the Underwriters' Equitable Rating Bureau, Portland, Oregon, has furnished special rules to govern the installation of these units.

Doubtless at the next meeting of the Electrical Committee of the National Fire Protection Association, new rules will be formulated to apply to the installation of these new units.

Until further advised the Bureau will expect the following requirements to be carried out in all cases where the new higher efficiency Mazda incandescent lamps are installed on old or new electrical installations:

(1) Each unit must be placed on a separate two-wire circuit.

(2) Each wire of the two-wire circuit must have the following capacity: a—No. 14 B. & S. gage rubber covered wire, or equivalent current rating in other installations, for the 750 watt, 100-120 volt unit; b—No. 12 B. & S. gage rubber covered wire, or equivalent current rating in other insulations for the 1000 watt, 100-130 volt unit.

(3) Each two-wire circuit must be protected by a two-pole cutout of not more than 10 ampere capacity for the 750 watt unit and not more than 12 ampere capacity for the 1000 watt unit; a—"Mogul Base" sockets or receptacles rated for 660 watts or more must be used with these units. See Rule 72, National Electrical Code—Sockets—under which we will accept any "Mogul Base" socket or receptacle, which is at present rated at 660 watts and has been approved by the Underwriters' Laboratories, Inc., if used in connection with the above units.

(4) Fixtures—When fixtures are installed with these units, properly designed fixture must be chosen which will safely radiate the heat which is developed by them.

EFFECT OF FORESTS ON RUN OFF.

BY J. C. STEVENS.

(Continued.)

We are able to present some very interesting data on the frequency and height of moderate floods of Merrimac River, in addition to those of maximum heights given in the foregoing table. To do this rationally, it is first necessary to define what constitutes a flood. The commonly accepted definition of a flood in such a rise in a river that lands not usually covered are overflowed. Usually a "danger line" is fixed, above which damage is likely to occur. Obviously such a danger line is purely arbitrary, and usually the developments on the banks of the stream are the governing factor. In an uninhabited country there would be no danger line. However, it is necessary to fix such a limit above which the river would be called "in flood" and below which the river would be normal or in moderate freshet. On the Merrimac River the gauge height of 15 ft. has been fixed as a danger line. I quote from Col. Burr's report, p. 24:

*** * * it was determined to class as floods only such rises as reached or exceeded a height of 15 ft. on the gauge and to consider such a rise as constituting only one flood between the times it passed 8 ft. on the gauge in rising and again in falling. In computing flood duration and discharge, consideration was given only to the period during which the river was above gauge 10 ft. These arbitrary limits were assumed after a thorough study of the hydrograph for the entire record and are believed to provide a fair basis for the analysis of flood characteristics. The effects that might result from the use of other similar limits are unknown, since no others have been tried, but there is no reason to expect that any other set of standards, selected within rational limits and without regard to results would lead to conclusions of a different character.**

The following table gives the essential facts adduced in Col. Burr's analyses:

Floods on Merrimac River.

Period.	Number of floods (above 15 ft. on gauge)	Number of days per year floods were above 10 ft. on gauge.	Average annual runoff during floods (in.)	Percentage of flood to annual runoff.
1st 9 years—1850-1858..	22	65.1	10.33	42
2d 10 years—1859-1868..	14	61.2	9.63	41
3d ten years—1869-1878..	16	62.8	10.20	44
4th 10 years—1879-1888..	13	54.1	8.32	38
5th 10 years—1889-1898..	13	49.2	7.49	34
6th 10 years—1899-1908..	15	56.2	9.24	42

The last column in the above table gives the average proportion of each year's yield that ran off as flood discharge. If the forestry theory is correct, we should see a progressive decrease in this percentage since the forest area on the watershed has increased, but the table shows the same percentage during the last period as obtained in the first, yet the forest area was 30 per cent greater.

There appears to be a period from 1850 to 1860 when floods were more severe than in later years. There also appears an increase in flood severity coincident with reforestation. Floods are always produced by peculiar and erratic climatic combinations and the slightly higher frequency in the first, third and last periods is due solely to such combinations and not in any degree to forest confluences.

I quote below the conclusions at which Col. Burr arrives in his report, page 31:

Deforestation of the basin continued progressively from the early settlements until about 1860-1870, and since that period forested areas have increased through natural causes by 25 per cent or more of the entire basin, notwithstanding the continuance of lumbering operations.

There has been no decrease in precipitation in the basin as a result of deforestation or any increase with the reforestation of 25 per cent or more of its area. The precipitation for 50 to 90 years at points within the basin or within a few miles of its borders shows tendencies or cycles that bear no relation to the changes in forest areas.

The average runoff through the river varies with the precipitation over its basin, and the percentage of runoff to precipitation is not appreciably affected by forest changes as great as 25 per cent or more of the basin.

The frequency of floods has not been decreased by reforestation or increased by deforestation.

Exceptionally high floods have occurred at intervals without respect to forest conditions. Flood heights have not been decreased by forestation or increased by deforestation, and the principal characteristics of floods are unaffected by forest changes. The duration of flood stages and the amount of runoff during such stages have not been affected adversely by deforestation or beneficially by reforestation.

Deforestation has not lessened the height of the river at low water or increased the duration of low-water periods, and the reforestation of 25 per cent or more of the basin has not had any beneficial effect on low stages of the river.

Variations in stream flow are determined essentially by variations in climatic conditions which move in irregular cycles independent of forest changes.

Periodic Variations.

A study of the foregoing records of long standing will reveal a tendency towards periodic variations. It is well known that wet and dry years occur in groups. Although an extremely wet year may succeed an extremely dry one, or vice versa, the tendency toward cycle or secular variations is very evident. This phenomena has an important bearing on the question of forests and water supply, chiefly because facts and data are often arrayed against the memory of the oldest inhabitant to establish or refute a theory of this nature.

It is an almost universal belief that the climate is changing; that floods, rainfall, temperatures, etc., are all "different than they used to be." No matter where one goes, the same statement is heard. It is a perfectly natural conclusion and results from two causes, one psychological, the other physical. As we grow older, our perspective undergoes an adjustment. We only retain impressions of those things that are associated in our memory with particular circumstances. "Man marks when he hits, but never marks when he misses." We recall wading snowdrifts to school. Today those snowdrifts do not seem so deep and we immediately conclude that they are not. The water in the "old swimming hole" was much deeper when we were boys; today it is only waist-deep and we think the river is smaller than it used to be. We visit a spring, after a lapse of years, from which we drank when boys; it doesn't seem so large nor the water so fine as then. The spring is the same, but

our conception of it has changed. Our memory of it is fixed by some isolated circumstance connected with it, while today we view it in the abstract, unconsciously comparing it with others we have seen since. A man's memory of high and low stages of rivers alongside of which he has always lived, is invariably governed by isolated circumstances and incidents which he does not remember consecutively. For this reason such evidence is always untrustworthy, and only those who have had occasion to gather evidences of this kind know how conflicting and untrustworthy they are.

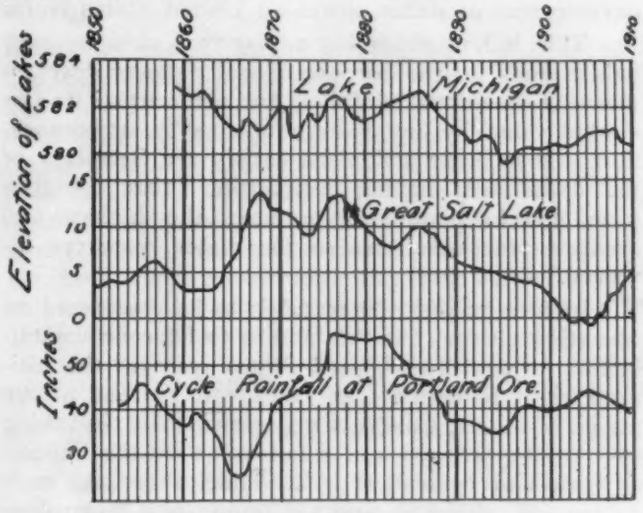


Fig. 5. Chart Showing Secular Variations in Physical Phenomena.

The second and principal reason for the universal belief that physical phenomena are changing is that they are actually undergoing continued changes, not, however, to the degree nor in the manner that is popularly believed. Rainfall, temperatures, humidity, winds, and consequently the stages of rivers and lakes, occur and recur with variable length and intensity. The major cycles are longer than the life of an average man—at least longer than his faculty for accurate recollection. Yet it is largely on such memories and on such data that the forestry and similar theories are frequently based. For this reason it is well to inquire briefly into the matter.

In order to show the secular variations in physical phenomena. I have prepared a diagram, Fig. 5, which is a graphical representation of the changes in water level of lake Michigan and of Great Salt Lake, Utah. These large bodies of water rise and fall with the major variations in runoff, evaporation, etc. They do not reflect minor variations, and therefore possess an averaging influence on these physical phenomena.

Great Salt Lake steadily fell from 1868 to 1905, and the general impression there is that the lake is drying up. But it was probably lower in the forties than in 1905. Since the latter date it has steadily risen. In order to show that these variations do conform to the cyclic changes in precipitation, I have shown the cycle rainfall (5 year averages) for Portland, Oregon. The water supply for Utah comes from the Pacific Ocean, and the Portland records or any other good record in the path of the vapor bearing winds, will indicate the yearly variations.

These two curves are approximately parallel, and show in a striking manner how closely related are the major climatic cycles and how broad their zone of influence. The changes in level of Lake Michigan and in precipitation on the Atlantic Coast, show a general correlation with those of precipitation and lake levels on the Pacific Coast. The causes of these variations are beyond the scope of man's endeavor. The mere cutting or planting of trees, tilling of land, or anything that man undertakes, will not nullify or modify the physical laws that govern these phenomena; his influence is limited to the uppermost film of the earth's crust. His greatest effort can scarcely effect material changes even there, and certainly cannot reach into the realms of earth and sky wherein originate the mighty forces that affect these phenomena.

From a study of the foregoing diagrams it is easy to see how one's impressions of the changes in climate will depend altogether upon the length and vividness of his memory.

These secular changes explain some of the progressive tendencies noticed in the runoff from the rivers heretofore cited. Thus the rainfall and runoff on Tennessee River appears to have persistently decreased since the beginning of the record in 1875, a period of generally high rainfall. If the record extended back 30 years farther, it would tell a different story. The Ohio record shows the same tendency, rising from 1860 to 1880 and gradually falling since. The precipitation record extends back much further and shows the same general tendency as seen in the New England record. The runoff would follow the same law if the record was of sufficient length.

(To be continued.)

Land telegraph systems in the United States numbered twenty-two, as of December 31, 1912, and these operated 247,528 miles of pole line, according to statistics just given out by the Bureau of the Census. One hundred three million, five hundred thirty-six thousand four hundred eighteen messages were transmitted, for which $56,293,469 was paid. The systems were at that time capitalized at $104,274,435 and the net earnings for the year amounted to $3,431,044. The employes number 35,639 and their wages were $23,797,980.

The new electrically driven collier Jupiter has scored a signal success on her trial trip, just completed off the Lower California coast. Though rated as a 14-knot boat, she maintained an average speed of 15.1 knots for forty-eight hours, her electrical machinery developing 5940 h.p. Electric propulsion is being tried by the Navy for the first time on the Jupiter, and the department officials are pleased with the result. The collier was in competition with the collier Neptune, fitted with a reduction gear on her turbines, designed to effect economy, and the Cyclops, fitted with reciprocating engines. All three vessels were of the same size and of similar lines, and the excellent performance of the Jupiter may have an important effect on future naval construction.

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Aiming to Aid

Heretofore bills introduced in connection with water power development have aimed to control development, and the resultant Government control has been so complete that stoppage of development has more nearly resulted. Statistics show that development has taken place, but it has been a harassed hazard, occurring to fill a compelling public need.

It is, therefore, of interest to note that the object of the bill introduced in the Senate by Mr. Jones on February 7, 1914, is to aid and to regulate the development of water power on United States lands.

This bill provides for a fifty-year occupancy of public lands for the purpose of water power development, at an annual rental of five per cent of its fair market value, by any State, municipality, or corporation, whose maps and plans satisfy the Secretary of the department having jurisdiction "that the proposed development will promote the highest and greatest practicable use of the water resources involved."

In rate making the rental is to be considered an operating charge, but the land is to have no capitalization value. The United States reserves the ultimate right to regulate all rates. At the end of the period of tenure, Congress may provide for the taking over of the properties at a fair value by the Federal or State Government, or by a municipality. All such values are subject to Court determination. Development of as much power as the market can absorb must be started within two years, and finished within five years. Water power is to be the dominant use, and this reservation is to be expressed in all patents issued for such land.

Is is also provided—for the ghost of that water power monopoly will not down—that works so constructed shall not be owned or leased by a monopoly or used in restraint of trade.

The law is retroactive, as it is provided that the rights to be granted will upon application, inure for the benefit of existing projects.

At first flush, this bill appears keyed right up to the highest point of utilization, and to promise fulfillment of President Wilson's policy of "a wise use," to represent the acme of simplicity, and to favor prompt and complete development.

The certain tenure stated, although not for so long a period as might be desired, should remove an objectionable feature which now exists, thus enabling capital for water power development to be more readily secured. It endeavors also to protect the developer against the appropriation of the land he now occupies by any claimant under public land laws, now possible merely on the ground of a claim initiated subsequent to the time the land was occupied for water power purposes.

As far as can be seen at present, the only combination, perhaps an unintentional conspiracy to limit the output of electric energy, is rate regulation which allows only a reasonable rate of return upon investment without reference to the standard of service rendered by the utility.

It will soon be appreciated that the public will be best served by this factor being taken into consideration. Utilization of investment and not investment alone should measure the rate of return.

These comments are gratuitous and of course previous, seeing that the bill is not yet law, but they are certainly pertinent to a full discussion of this measure, which leans toward complete development, and apparently aims to aid.

Efficiency and the Individual

What is time? What its relationship to the power which actuates—achieves? The age of Methuselah is not a prospect of those who live in the present, but can it be said that they accomplish less? Time, though necessary to accomplishment is but incidental.

Getting equal results with the lapse of less time than heretofore, or better results in the same time, constitutes efficiency. But efficiency is not time. Efficiency is the power that accomplishes.

An efficient individual is one with active interest plus adequate knowledge and skill for the performance of the thing to be accomplished.

Incentive to utmost endeavor should not depend upon the bare necessity for accomplishing certain tasks according to schedule, but upon the very love of accomplishment.

Man has that in his headpiece which is more exact, or at least more exacting, than any timepiece. That which imperatively commands him to do that which is right, and to abstain from the wrong.

Great work, art for example, is but the expression of man's joy in what he does.

If you contemplate accomplishment merely because of lapse of time, you will be disappointed. Accomplishment consists in both having and exercising the power to get results.

In getting that knowledge and in its application, there are certain principles of efficiency—certain fundamental causes that tend to naturally produce better results—which it is advantageous for the individual to know and use.

But if standards are adopted they should be elastic, for progress and improvement cause changes which must be conformed to. The efficient individual does not act with reference to the past, but recognizing the practical requirements of the present, interprets its passing spirit.

To do things with past performance as a standard is to deteriorate. Things done in the past are but milestones on the pathway of progress. They but show the advance, and point to the better way.

Augmented by imagination, planning for the distant future may or may not bring success. It is not wise to plan too far ahead else the arrival of that time may find the most efficient ideas of the past then an ignorance. Efficiency thrives in the now.

If you would be efficient, excel in everything. Be earnest, enthusiastic, loyal to your ideals and to others. Then with ambition, application and industry you will succeed.

There is but sparse competition among the men who intelligently and persistently strive.

Theorizing is often waste of time. Get action if the subject is beyond you. The solution of your problem will meet you half way if you but make a move towards it.

The efficient individual makes system an accessory, a means of accomplishing the desired end. The majority of systems are stately sarcophagi for the decent interment of dead dope. Relinquish that burden.

It is not a passive content with results but an intelligent discontent which makes for happiness and success, but in that discontent must be found the principles of individual efficiency if it is to be constructive and not the destructive force it generally is.

And about those ideals. Remember that they are a means to an end, and that end, efficiency—results.

The Joint Meeting

A compelling force is being discovered in the joint meeting with other engineering, and societies with allied interests. It widens knowledge, makes for a better understanding, and not only strengthens the position and enhances the arguments of all, especially as relating to questions of a more or less public nature, but is also urging, as a matter of economic necessity and natural development, that the professional engineer revise his present concept of what constitutes engineering practice; in this way emphasizing his civic duty and opening up several new channels as outlets for his qualified endeavor.

Engineers are proving continually that they can handle involved situations just as readily as they handle materials and forces. And why not?

The main purpose of the medical doctor is to cure disease but this does not hinder him from pursuing activities which tend to prevent those same diseases.

It does not detract from their dignity to do other than prescribe powders and pills.

And the joint meeting is discovering the engineer and bringing him into his rightful place of leader. It is beyond contradiction that the engineer has facilitated progress in all departments of endeavor—that he has been largely responsible therefor. He has therefore, nothing to gain by hiding his light under the bushel of a mistaken dignity.

It may be stated that it is the province of the professional man, whether doctor, lawyer, or engineer, to use his specialized knowledge which is power, openly, in the interests of the public.

As so pointedly stated in our leading article of this issue, the public, especially on matters involving engineering knowledge, is not a reasoning public, but governed largely by sentiment. The engineer can still further fulfill his part by actively aiding the people.

Intended to serve completely certain interests, a society is sometimes formed though there are other societies in existence which could separately solve more satisfactorily the difficulties arising. But coordination is lacking.

Eventually the society finds that its endeavors along certain lines are eclipsed by the specializing societies and gladly surrenders those phases of its work. The joint meeting results.

Specialization calls for co-operation, and co-operative effort completes the cycle by pointing to the necessity for specialization.

PERSONALS

ITEMS FOR THIS DEPARTMENT ARE SOLICITED FROM ALL READERS

W. R. Lyall, of the D. & W. Fuse Company, was at Seattle last week.

Marshall Tiebout Gleason, of the Gleason Tiebout Glass Company, is at San Francisco.

Ben Scranton, president American Electrical Heater Company, was at Seattle this week.

C. W. Baker, district engineer, Westinghouse Machine Company, San Francisco, is at Los Angeles.

H. E. Sanderson, Pacific Coast manager, Bryant-Perkins Company, was at Seattle during the past week.

A. C. Balch, vice-president, San Joaquin Light & Power Company, is dangerously ill at Los Angeles with typhoid fever.

H. C. Hazard, secretary, Pacific Coast Electric Railway Association, is at Los Angeles from Portland, Oregon.

H. A. Kluegel, chief engineer, Mt. Whitney Power & Electric Company, was a visitor at San Francisco during this week.

F. H. Legget, Pacific Coast manager, Western Electric Company, is making a business trip through the Pacific Northwest.

Clem A. Copeland, electrical engineer, Pacific Gas & Electric Company, is making a trip throughout Eastern business centers.

G. W. Johannsen, Pacific Coast representative Draeger Oxygen Apparatus Company, is at Los Angeles from San Francisco.

T. Mirk, of Hunt, Mirk & Company, San Francisco, is at Los Angeles, and will make a business trip throughout Southern California.

H. V. Carter, president, Pacific States Electric Company, has left San Francisco on a business trip throughout the Pacific Northwest.

L. E. Torrey, of San Francisco, left the early part of the week for Crescent City, Cal., where he will appraise the light and power plant of that city.

Ernst Kaiser is at San Francisco to study the possibility of using high voltage electric boilers for hydroelectric companies having a surplus of power.

H. H. Barrows, superintendent Oakland Lamp Works of General Electric Company, has been elected a member of the Illuminating Engineering Society.

J. B. Lukes, representing Stone & Webster Construction Company, returned to San Francisco from Boston, but has left for Los Angeles on business.

David W. Johnson, municipal engineer Point Grey, since its incorporation, has now been appointed to the same position for the municipality of Saanich, B. C.

A. G. Wishon, general manager and **A. E. Wishon**, assistant general manager, San Joaquin Light & Power Company, were at San Francisco during the past week.

E. S. Berdine, Pacific Coast representative, Gleason Tiebout Glass Company, has just returned from a business trip made throughout his territory and reports good business.

T. E. Collins, sales manager, Westinghouse Electric & Manufacturing Company, San Francisco, has just returned from a business trip made through the San Joaquin Valley.

S. P. Russell, manager electrical department, H. W. Johns-Manville Company, San Francisco, has returned from New York, where he was in attendance at the company's convention.

C. W. Whitney, erecting engineer, Westinghouse Machine Company, is at Visalia, Cal, superintending the erection of a turbine for the Mt. Whitney Power & Electric Company.

Ernest L. Clark, president of the Valentine-Clark Company, cedar pole specialists of Minneapolis, Minn., is studying conditions on the Pacific Coast. He is at present at Los Angeles and will return to Minneapolis by way of Seattle.

Henry F. Holland is at Los Angeles renewing old acquaintances, made during his residence in that city some two years ago, and to look after the Western interests of the Simplex Heating Company of Cambridge, Mass. Mr. Holland is a Jovian statesman-at-large, and is staying in this city for an indefinite time.

E. G. Eagleson, of Boise, was elected president of the Idaho Society of Engineers at the Fifth Annual Convention held recently at Boise, Idaho; **R. J. White**, of Wallace, was elected vice-president; **F. H. McConnel**, of Caldwell, treasurer; and **Ira F. Staffner**, secretary. These officers, together with **J. P. Congdon**, of Boise; **F. A. Wilkie**, of Ashton; and **E. A. Wilcox**, of Twin Falls, constitute the executive board.

F. R. Glover, general executive assistant, British Columbia Electric Railway Company, Vancouver, B. C., gave an address last week on the history of that company, and during its progress drew many interesting comparisons between the attitude of municipalities toward ownership of public utilities in the lean days of development and loss, as compared with that of the present days of deservedly earned profits. The address was enjoyed by all those who heard it.

J. Paulding Edwards, who for the past eight years has served the Northern Electric Railway Company in the capacity of consulting, constructing and operating electrical and mechanical engineer, has retired from the construction and operating departments of this company, and has been appointed consulting engineer for the company, with headquarters at 201-202 Farmers and Mechanics Bank Building, Sacramento, Cal. In addition to his work for the Northern Electric Railway Company, Mr. Edwards has entered upon general practice as consulting engineer.

MEETING NOTICES.

Jovian Dance at Sacramento.

Members of the Jovian League at Sacramento, Cal., have arranged to give a dance at the Elks Hall, Sacramento, on Saturday, February 21, 1914. Members of the Jovian order and electrical men in general are invited to attend and so contribute to the success of the occasion.

Oregon Electrical Contractors.

At the meeting held at the Commercial Club on Wednesday evening, February 11th, it was decided that the second annual convention of the Oregon Electrical Contractors' Association would be held at Portland, Oregon, June 8th and 9th, 1914, and J. R. Tomilson was elected chairman of the convention committee.

Manufacturers' exhibits are solicited and all "out of town" manufacturers' exhibits will be erected by the association free of charge..

Jovian Electrical League of Southern California.

The weekly luncheon held at Christopher's, Los Angeles, on February 11th, was attended by 87 enthusiastic Jovians, who listened to an inspiring and helpful talk by John Willis Baer, L.L. D., president of Occidental College, on "Man's Morning." Dr. Baer is a forceful and accomplished orator, and his thirty-minute address on the exercise of manhood in business dealings was a source of inspiration and mental recreation to the audience. A number of out-of-town visitors were introduced. A. L. Spring was chairman of the day.

Utah Electric Club.

The smoker given at the Commercial Club on Thursday evening, February 12th, under the direction of the entertainment committee, was the most successful social stunt in the history of the club. More than 200 members and guests were present and enjoyed to the fullest extent the program of boxing, wrestling and jiu-jitsu matches, which were freely interspersed with music by the troubadors.

The feature bout of the evening was a fifteen-minute amateur contest for the Utah Electric Club medal, to be participated in by club members only. C. J. Welti, of the West-

ern Electric Company, was given the decision over A. Young, of the Intermountain Electric Company, by a narrow margin.

Seattle Jovian League.

The Seattle Jovian League held its weekly dinner Friday, February 13th, at the Hotel Washington Annex at 6:30 p. m. The speaker of the evening J. R. Irwin of the Marconi Wireless Telegraph System, described the possibilities and accomplishments of the wireless field. Mr. Irwin was the wireless operator who accompanied the Wellman Expedition which made an unsuccessful attempt to cross the Atlantic a year or so ago. His talk was very interesting and thoroughly enjoyed by about thirty-five Jovians present. Other speakers of the evening who talked on co-operation were George R. Cooley, Mr. Gilley of the Puget Sound Traction, Light & Power Company and Mr. Cheney of the National Board of Fire Underwriters. Several selections by the Hill Quartet were rendered.

San Francisco Electrical Development and Jovian League—Alameda County Electrical Development League.

A joint meeting of these associations was held at the invitation of the San Francisco Electrical Development and Jovian League at Tait's Cafe, San Francisco, last Tuesday. The Alameda Electrical Development League, as visitors, being well represented.

W. F. Neiman and G. B. Furniss, presidents of the respective leagues, occupied the chair jointly, assisted by Carl B. Heise, vice-president of the San Francisco League.

G. B. Furniss stated what their league had done for the industry in general in Alameda County, and then called upon various members to give their views. Other addresses were also given by representative members.

It is expected that this is the forerunner of many combined meetings of a similar nature. There was a musical program also, well rendered.

NEWS OF THE CALIFORNIA RAILROAD COMMISSION.

The railroad commission has fixed March 1, 1914, as the date at which the new express rates of the Wells Fargo Express Company shall be effective in California. The effect of the decision is to reduce express revenues paid by the people of California by $750,000 per annum.

The railroad commission rendered a decision February 14th granting authority to the San Diego & Arizona Railway Company to issue $10,000,000, in bonds and $3,000,000 in stock for the purpose of completing its line of railway from San Diego into the Imperial Valley. The line will be approximately 140 miles in length. It will serve not only to connect the rich Imperial Valley with the port of San Diego, but it will form the western link of a possible new transcontinental railway with its terminal at San Diego.

The commission has issued a supplemental order authorizing the Southern Pacific Company to pay to the bankers and underwriters' syndicate a sum not to exceed $25,000 to cover the expenses in connection with the flotation of the $55,000,000 bond issue authorized by the commission the 9th instant. The order also authorizes the payment of the 5 per cent one year notes of the company due June 15, 1914, in the sum of $26,000,000; also a loan due May 29, 1914, in the sum of $4,500,000 and also the payment of $3,000,000 due for equipment already purchased.

The Mount Whitney Power & Electric Company has filed an application with the railroad commission, asking for authority to issue $500,000 first mortgage 6 per cent bonds; the bonds to be sold at not less than 95 per cent of their par value and accrued interest. The applicant supplies electricity to the inhabitants of Tulare and Kern counties and the funds are to be used in its hydroelectric development work on the Kaweah River.

The commission has issued an order in which it finds that the Soledad Land & Water Company, operating an irrigation system in the Salinas Valley above King City, is a public utility, and directing the company to adopt and to file with the commission rules and regulations containing provisions for the delivery of water to the land of consumers, and containing provisions that a minimum rate of $2.25 per acre per year be charged for water. The defendant held that it was not a public utility; that it could require its consumers to take water from a pumping plant; could not be compelled to operate ditches and laterals and deliver water through them to the lands of the consumers and that its rates to its consumers were not subject to review.

The Union Hollywood Water Company has filed a complaint with the railroad commission against the Pacific Electric Railway Company, complaining against the damage alleged to be sustained by the underground pipes of the Water Company which run parallel to the right of way of the railway company.

The commission has established joint freight rates between points on the San Pedro, Los Angeles & Salt Lake Railroad and the Crescent City Railway.

RAILROAD COMMISSION OF OREGON.

"The attention of the commission having been directed to a supposed dangerous condition in the operation of the underground conduits with respect to the protection of manholes while work is being performed therein, and also to the necessity of protection of cables in manholes undergoing repairs from moisture, a conference is hereby called at the commission's office in Portland, Oregon, 252 court house."

This order was issued because of a fire in an underground manhole which interrupted the municipal fire alarm system, the Western Union Telegraph System, the Pacific Telephone & Telegraph System, and the Denio Telephone Fire Alarm Company's System.

NEWS OF THE ARIZONA CORPORATION COMMISSION.

The commission ordered that the Holbrook Light & Power Company be granted authority to engage in business at Holbrook, the county seat of Navajo County, Arizona System of accounts to be that ordered by the commission and all construction and standards of construction to comply with the laws of the state. All sales of stock of company heretofore made, are void, the sale of an issue of $30,000 of common stock having been made without authority or permission.

The International Gas Company, Nogales, Arizona, was given permission to charge a monthly minimum of $1.00 per meter for gas.

BOOK REVIEWS.

Switches and Switchgear. By Professor R. Etler; translated by C. H. Laubach; 450 pages; 5½x8½ in.; cloth bound. Published by D. Van Nostrand Company, New York City, and for sale by Technical Book Shop, San Francisco. Price $4.

This excellent translation of Professor Etler's extensive work gives the engineering fraternity of England and America access to much theoretical information not ordinarily available. Regarded from a historical standpoint, this book is of great value, and should prove useful to designing engineers, but as most of the apparatus illustrated and described is of European manufacture, the details are of little value to operating engineers in this country. The ten chapters may be divided into five divisions. The first gives general information on the design of switchgear; then follow details of manufacture and design of small parts. The next subject is that of low pressure switchgear, followed by chapters on high pressure switches, and concluded by information on fuses, circuit-breakers and controllers. This text book would make an excellent addition to the library of any engineer interested in the development of this branch of electrical design.

THE ELECTRICAL CONTRACTORS' DEPARTMENT

A TYPICAL FRUIT PACKING HOUSE INSTALLATION.

BY N. W. REED.

The nature of the work carried on in buildings of this character makes it necessary to use a type of electrical fittings and a method of installation somewhat different from those used in a mercantile risk.

The following suggestions are based on requirements of the National Electrical Code. All electric fittings such as fuses, wire, switches, conduit, etc., should be Code standard. All references relate to the Code and should be so read. All work, other than that specifically mentioned herein, should be done strictly in accordance with requirements of the Code.

Main Fuses and Switch: All fuses and switches should be placed within reach, main fuses to be located at nearest accessible point to where wires enter building. (Sec. 23a.) Switch to be readily accessible and may or may not be with the fuses; a satisfactory place is with the meters or on main switchboard; it should, however, cut off the entire current, including meters. (Sec. 24a.)

Main Switchboard: Slate or marble mounted on an angle iron frame is best for switchboards, although a wood skeleton frame is suitable for a small number of large switches. In case several switches, fuses and other apparatus such as meters are to be mounted together, a wooden board covered with ⅛ in. asbestos would be satisfactory, provided no complicated wiring is to be done and all wires are kept on face of board.

In order to protect meters, fuses, switches, etc., on switchboard from mechanical injury, two heavy posts may be placed at each end of the board and about a foot in front of switches. A wooden frame covered with strong wire netting can be made which will slide up and down in front of the board by supporting the frame with window weights, similar to an ordinary window.

Fuses for Lighting Circuits: Fuses should not be placed on roof timbers or in other non-accessible places but should be grouped together at some point easy of access and where not subject to injury. (Sec. 23a.) A sufficient number of circuits should be provided so that more lights may be added and other small changes made at a later date. Fuses must be arranged so that no set of small motors, lamp sockets, receptacles requiring more than 660 watts or more than 16 sockets or receptacles are dependent upon one fuse. (Sec 23d.)

Note: This will not permit 16 sockets on a circuit if over 40 watt lamps are used and the ordinary 16 c.p. carbon lamps requires over 40 watts.

Fuses for these branch lighting circuits should not exceed 10 amperes.

Fuse Cabinets: If fuses are places in cabinets the cabinet should be well constructed and door self-closing. Bottom should be preferably on a slant so cabinet will not be used for miscellaneous storage. A wooden cabinet should be of at least ¾ in. material, painted and lined with at least ⅛ in. rigid asbestos. Doors should also be lined and close against a rabbet to be dust tight. A poorly made cabinet is worse than none. (Sec. 70.)

Supports for Wires: For open knob and tube work, wires must be kept 2½ in. apart and supports placed at least every 4½ ft. In dry places wire must be kept ½ in. from surface wired over and in damp places must be kept 1 in. from surface wired over. (Sec. 26g-h.)

Protection of Wires: Where ceilings are low or where roof timbers are far apart, do not run wires from beam to timbers and then cleat wires and fasten lamp receptacles to beam. In such places a simple method is to nail a "running board" such as a strip of 1x6 in. or 2x6 in. depending upon length of span, to the lower edge of ceiling joists or roof timbers and then cleat wirs and fasten lamp receptacles to under side of running board. (Sec. 26e.)

Protection on side walls, such as where wires come down to fuse cabinet may be accomplished by using double braid wire and placing wires in conduit, provided conduit is equipped with approved fittings and installed in accordance with requirements for conduit work. (Sec. 28.) Instead of conduit, the wires may be boxed in, when they should be kept 5 in. apart and 1 in. off surface wired over, that is, requirement for concealed work should be complied with. (Sec. 26q-t.)

Lamp Pendents and Flexible Cords: The ordinary lamp cord should not be used at all in a warehouse or packing room. If it is absolutely necessary to use a long cord extension for a portable lamp, then use a cord approved for this rough usage; such cords are known as "packing house" or "portable" cord (Sec. 54c.) For lamps not carried about, keyless weather-proof sockets could be used and suspended by twisted No. 4 stranded wire supported by a cleat and soldered to circuit wires. To control the lights, switches could be placed in fuse cabinet or snap switches placed in any convenient place.

TRADE NOTES.

The Multigap Spark Plug Company has been formed at Twin Falls, Idaho, to manufacture a spark plug recently patented by J. W. Nance.

Bids are to be opened at Fresno, Cal., on March 1st for 487 electroliers. Plans and specifications may be had from P. M. Robinson, city electrician.

B. E. Davis Electric Machinery Works, 103 E. Water street, Portland, Ore., is installing the electrical equipment in the City Market, Ice & Cold Storage Company's new addition.

Bids are now being invited by the San Francisco Board of Public Works on the electrical equipment of the new city hall. Plans and specifications were prepared by Hunter & Hudson.

F. M. Vanderlip has secured the contract for the electrical installation in the new cold storage and warehouse building being erected on the southeast corner of E. Alder and Railroad streets, Portland, Ore.

The Oregon Electric Welding & Enameling Works, controlled by Ward Watkins, has been established at 275 Hawthorne avenue, Portland, where a specialty is made of electric welding by the Thompson process.

The W. H. Smith Electric Engineering Company, Spaulding Bldg., Portland, Oregon, was awarded the electrical contract for the lighting system on the first unit of the municipal dock, Portland, Ore. The contract for the installation of the power system will be awarded at a later date.

The Western States Gas & Electric Company, Richmond, Cal., division, has closed a contract with the Shattuck-Edinger Company for 225 h.p. and a small lighting load. The power will be used by the Shattuck-Edinger Company in constructing the highway and tunnel to Richmond's outer harbor. The contract is for eight months.

The city of Pendleton, Oregon, has installed a twenty-one box municipal fire-alarm system. It is is a standard installation, consisting of a two circuit switchboard, storage batteries, bell striker, repeater and punch register. All the apparatus was furnished by the Gamewell Fire Alarm Company through their Seattle office.

NEWS NOTES

INCORPORATIONS.

LOS ANGELES, CAL.—Independent Electrical Supply Company, $25,000, subscribed $5, by I. E., I. H., E. and J. Irvine and H. Schwartz.

LOS ANGELES, CAL.—International Electric Lighting Company, $500,000, subscribed, $5, by B. T. Wilson, D. W. Shoemaker, T. L. Croom, H. W. Janicke and Mary W. Croom.

ILLUMINATION.

BAKER CITY, ORE.—The city of Baker has purchased from the Eastern Oregon Light & Power Company the entire arc lighting system in Baker for $4250.

MOLALLA, ORE.—An ordinance has been passed granting to Fred Schafer the right to erect poles and stretch wires for the purpose of transmitting electricity.

RIO VISTA, CAL.—A. Erwin of Winters, who has established a gas plant at that place, and also one at Vacaville, was here recently looking over the situation in regard to establishing a gas plant.

WASCO, ORE.—R. C. Atwood and W. H. Lee have been granted the right to erect poles, wires and other apparatus for the transmission of electricity for lighting and power purposes in the city of Wasco.

SACRAMENTO, CAL.—Bonds to the extent of $1,000,000 were authorized recently by the directors of the Sacramento Natural Gas Company. This bond issue was authorized in order to provide for extensions.

ANAHEIM, CAL.—The Southern Counties Gas Company has secured permission from the board of supervisors for laying gas mains from the La Habra district for the purpose of supplying natural gas to Anaheim and other towns.

FLORENCE, ARIZ.—Fred Tribolet and I. D. Rickerson of Ray, Arizona, have petitioned the Board of Supervisors of Pinal county, for a franchise to conduct an electric light, power and telephone business in and about the town of Superior.

GLOBE, ARIZ.—In response to a petition filed with the city council in October, 1913, the public utilities committee has made a report to the city council on the proposed installation of municipal lighting system. According to the estimates of the committee the cost of the system would not exceed $80,000.

LOS ANGELES, CAL.—Plans and specifications for installing ornamental iron lighting posts and furnishing current for ornamental lighting of Westmoreland boulevard, from Sixteenth to Washington streets, has been prepared by the city engineer and adopted by the board of public works. The council has set February 25th as the date for hearing protests to the proposed improvements.

SEATTLE, WASH.—A bill, introduced some months ago, providing for a reduction in the city's lighting rates from 6 to 5½ cents per kilowatt hour for the first sixty kilowatts, was put over another week, after more than half an hour's discussion. It was recommended for passage by the city utilities committee, but, discussion of the measure brought out the fact that a majority of the council is not ready to vote either for or against it.

SALT LAKE CITY, UTAH.—The Utah Light and Railway Company have made a proposition to the City Commission to furnish a blanket bond of $50,000 to the city, replacing the bond which is now required by the city from individual owners of electric signs to protect the city against loss by reason of damages to pedestrians from falling signs. The company is willing to do this in consideration of the commission's specifying a definite amount of illumination to be provided on each electric sign and requiring that all signs must be illuminated at least between the hours of dusk and 10:30 each evening. This blanket bond will relieve the sign owners from the expense and annoyance attendant upon furnishing an individual bond, and will have a tendency to improve the character of the electric signs installed in the city.

TRANSMISSION.

ASTORIA, ORE.—The Seaside Light & Power Company will probably extend its transmission line across Clatsop plains to the south line of Warrenton this spring, according to Manager F. J. Keyes now in charge of the plant.

SEATTLE, WASH.—The Cedar River Dam for the new city hydroelectric plant is being reared at a rapid rate by the contractors. Nettleton-Bruce-Eschbach Company, American Bank Building, Seattle. The dam will be 700 ft. in length, 200 ft. wide at the base and 215 ft. high.

CENTRALIA, WASH.—At a meeting held at Vancouver stockholders of the Washington-Oregon Corporation which operates power lines in Southwest Washington from Tenino to Kalama, the proposition of erecting a new $250,000 power house on the Kalama River was considered. It is stated that the proposed plant will be located about a mile below the old one.

RIVERSIDE, CAL.—Lee Utley, representing the Coachella Ice & Electric Company, has applied to the board of supervisors for a franchise for the distribution of electric power in the Coachella valley, from Banning to the Colorado River. Date of sale of franchise was fixed for March 18th. The company proposes to take power from the Southern Sierras Power Company at Banning and distribute it throughout the valley.

SEATTLE, WASH.—The United States attorney general has filed suit through the local district attorney's office against the Puget Sound Traction, Light & Power Company, for the revocation of five claims on the Nooksak River near Bellingham, on which is located a $2,000,000 power plant of the company. It is charged in the complaint that the patents to the claims were obtained through fraud and misrepresentation. The government alleges that the claims were filed on by P. B. Cornwall, a San Francisco capitalist; Alvinza Hayward, P. D. Connelly and D. O. Mills in 1902, and that Cornwall obtained deeds to the claims from the other three and a little later made applications for patents.

PROVO, UTAH.—The Olmstead power plant of the Utah Power and Light Company was thrown out of commission last week when 250 ft. of the flume leading to it from the Provo River was carried away by a snow and mud slide. In switching off the current when the water broke, Hyrum Fowler, superintendent of the plant, and H. Nason, his assistant, were slightly burned about their faces by an exploding arc. The water tore a great hole in the side of the mountain, leaving a sheer drop of more than 100 ft. where the flume formerly stood. S. R. Inch, superintendent of the Power Company, has a force of men at work on the foundations for a trestle which will carry the flume over the washed-out portion. He states that the service of the company has not been impaired by the loss of 4000 kw. from the Olmstead plant, owing to their ability to secure sufficient capacity from their other generating plants.

HOOD RIVER, ORE.—Hood River Valley citizens in mass meeting voted to organize about ten square miles of the valley into a municipality under a commission form of government to develop public utilities. The territory will have a population of about 6000, with an assessed valuation of approximately $6,000,000. The new municipality is the outgrowth of sentiment adverse to the Pacific Power & Light Company, of Portland, which controls the electric power and light privi-

leges of the Hood River section and which is charging the farmers 13 1-3 cents per kw.hr. It is proposed to install a municipal light plant and the territory included in the municipality to be organized will be bonded to install the plant. A motion was also passed at the mass meeting to initiate a state bill giving any rural community power to organize a municipality and to install any public utility without the necessity of the governmental requirements of the cities.

LOS ANGELES, CAL.—The three power corporations submitted to the special committee on power of the City Council a request for 10 days' additional time in which to accept or reject the contract submitted by the City Council to the corporations for the leasing of the power distributing systems, with an option to purchase them. The 10 days' additional time is necessary in order to receive the written opinion of attorneys for the trustees of their bonds, who are now considering the contract in New York City. In this connection a telegram was received by City Attorney Stephens from Dillon, Clay & King, bond experts of New York and Chicago, stating that this firm has been employed by the trustees of the bondholders of the Los Angeles power corporations. The bond experts asked whether the city would be willing to enter into a contract with the power corporations for the lease of their distributing systems. The telegram from the bond experts clearly indicates that the subject is being seriously considered by the trustee of the bondholders, and city officials are rejoicing over the prospect of this question being closed.

TRANSPORTATION.

LEWISTON, IDAHO.—The building of the 12 miles of line out of Lewiston is assured by the Nez Perce & Idaho Railway Company by the securing of a fund of $50,000.

PORTLAND, ORE.—An ordinance has been passed granting to the Portland & Oregon City Railway Company the right to construct railways, poles, wires, etc., in the city of Portland.

LOS ANGELES, CAL.—The application of the Pacific Electric Company for a franchise on Normandie avenue as a connection with the Torrance-El Segunda line, has been referred by the city council to the public utilities committee.

SAN FRANCISCO, CAL.—To expedite the delivery of materials for the construction of the new Municipal Railway lines, the city engineer has divided the present freight orders among the three transcontinental lines having terminals here.

SALT LAKE CITY, UTAH.—Three gasoline motor cars which were ordered to operate on the Orem interurban electric line between Salt Lake City and Provo pending the completion of the installation of the electrical equipment, arrived here from California under their own power last week. The cars are 61 ft. over all, and have a seating capacity of 60 passengers. Each is equipped with a 150 h.p. gasoline motor.

SAN DIEGO, CAL.—The San Diego Electric Railway Company is making preparations to expend $250,000 in improvement of its tracks on Fifth street, by replacing rails on Fifth street from Ash to University streets with Trilby or grooved rails of 114 lb. to lineal yard, and repaving the street with concrete base and asphalt surface. The rails on Fourth street from Broadway to Sixteenth street will also be replaced with 114 lb. rails.

SACRAMENTO, CAL.—Plans which will increase the efficiency of the Sacramento street railway service and which, if accepted, will necessitate the complete remodeling of the downtown system, are being formulated and will be submitted to the Pacific Gas & Electric Corporation for approval. The plan is to establish belt lines in the business district, construct new lines on I and L streets, and relieve the congestion of traffic on K and J streets, by temporarily creating a single track system in the downtown section.

OGDEN, UTAH.—In response to a communication from P. D. Kline, manager Ogden Rapid Transit Company, the Board of City Commissioners has ordered all poles removed from the center of the streets on which street car lines are operated. This order will involve a considerable expense to the Ogden Rapid Transit Company, the Utah Light and Railway Company, the Utah Power and Light Company, and the Mountain States Telephone and Telegraph Company, all of whom maintain distribution systems in Ogden. This order was made necessary by the fact that the Transit Company proposed to inaugurate a pay-as-you-enter system on its lines by April 15th.

SAN FRANCISCO, CAL.—Three tentatve propositions, involving the extension of the Municipal Railway line from Stockton street across Market and thence down Fourth street to the Southern Pacific Depot over tracks of the United Railroads, has been submitted to the supervisors by the North Beach Promotion Association. With the United Railroads occupying Fourth street and assuming that the five-block limitation will prevent the city from going the entire distance, three different plans are suggested, First—the outright purchase of the right of the city to run municipal cars over Fourth street, or, second—payment to the United Railroads of part of fare collected for every passenger traveling on Fourth street, or, third—an exchange of rights, allowing the United Railroads to run a certain number of cars over the Stockton street line from the Southern Pacific depot to the Exposition grounds.

OAKLAND, CAL.—Thirty-five million dollars is the amount estimated by General Manager McLimont of the Santa Fe-Oakland Terminal Railways as necessary for the refinancing and improving of the Key Route and Oakland Traction properties and their future development along the most modern ideas of trasportation efficiency. This sum does not include the proposed extension of the Key Route to San Jose or Sacramento, but it is to be devoted to refunding outstanding bonds and to the extension and improvement within the immediate vicinity of Oakland. George C. Moore, representing the interests that recently looked over the traction properties, is now in London seeking a loan of $15,000,000 to finance the scheme, in addition to the $20,000,000 which is to be spent to buy up the outstanding bonds of the traction company, and it is expected that as soon as the final arrangements are made for the financing of the system the work of improvement will begin.

TELEPHONE AND TELEGRAPH.

LOS ANGELES, CAL.—By unanimous vote the City Council adopted the ordinance that consolidates the bureau of fire alarm and police telegraph with that of the City Electrician, and provides for the creation of an advisory board to assist in the planning of a comprehensive alarm system for the city. City Electrician Manahan thus becomes head of the fire alarm and police telegraph bureau, in addition to his duties as City Electrician, and assumes even greater responsibilities than those of his original office.

LOS ANGELES, CAL.—The Wheeler resolution, referred last week to the Public Utilities Commission of the City Council, after reciting the conditions at present that cause a double tax for telephone service on business houses and stating that other municipalities have found an interchange of service advantageous, then proceeds: "Now, therefore, Be it resolved, by the City Council, that the Board of Public Utilities of this city be and they are hereby instructed to work out a method providing for such an interchange of message from one system's lines to those of another, and establish, telephone rates with such interchange of message provided for as soon as possible, to the end that when the telephone rates are next fixed according to law they shall provide such method of interchange of messages, and thus be a great convenience, advantage and saving to the people of this city."